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K/TSO-001
Rev. 5

UF_6 Cylinder Project
System Requirements Document

Enrichment Facilities Management

July 1998

Prepared by
Enrichment Facilities Management
East Tennessee Technology Park
Oak Ridge, Tennessee 37831-7239
managed by
Bechtel Jacobs Company LLC
for the
U. S. Department of Energy
under contract
No. DE-AC05-98OR22700

Change Page Notification for
UF_6 Cylinder Project System Requirements Document
K/TSO-001, Rev. 5

Page	Paragraph	Change	Reason
8,9		Delete 49 CFR, ASME Boiler & Pressure Vessel Code and NBIC from list of "other pertinent standards."	The standards deleted have been picked up in the Phase II Work Smart Standards which has been recognized in the Bechtel Jacobs Company LLC contract.
8, 38, 39		Replaced DOE 5480.24 with ANSI 8.1, 8.3, 8.7, 8.19, and 8.20 as applicable.	To obtain consistency with Phase II Work Smart Standards and Bechtel Jacobs Company LLC contract.
App. A		Add ANSI/ASME B31, National Boiler Inspection Code, and ASME Boiler and Pressure Vessel Code.	Update the applicable Work Smart Standards for the UF_6 Cylinder Project per the Bechtel Jacobs Company LLC contract..

The above table identifies the substantive changes in the Systems Requirements Document from Rev. 4 to Rev. 5. Bechtel Jacobs Company LLC, requests your approval of these changes. Approval is accepted when following signatures are present:

Signature of the Requesting Organization:

M S Taylor 7/27/98

M. S. Taylor, Three-site Project Manager

Signature of the Concurring Organization:

Joe W Parks 7/27/98

J. W. Parks, DOE-ORO Assistant Manager for Enrichment Facilities

K/TSO-001, Rev. 5
UF_6 Cylinder Project
System Requirements Document

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ACRONYMS

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
DFO	Directors Findings and Orders
DNFSB	Defense Nuclear Facilities Safety Board
DOE	Department of Energy
DOT	Department of Transportation
DU	depleted uranium
DUF_6	depleted uranium hexafluoride
EDP	Engineering Development Plan
EMEF	Environmental Management and Enrichment Facilities
ES&H	environment safety and health
ETTP	East Tennessee Technology Park
ID	identification
LMES	Lockheed Martin Energy Systems, Inc.
MO	Major Objective
NBIC	National Board Inspection Code
NMC&A	Nuclear Material Control and Accountability
PEIS	Programmatic Environmental Impact Statement
PGDP	Paducah Gaseous Diffusion Plant
PORTS	Portsmouth Gaseous Diffusion Plant
PMP	Project Management Plan
S/RID	Standard Requirements Identification Document
S&M	surveillance and maintenance
SARs	Safety Analysis Reports
SEMP	Systems Engineering Management Plan
SRD	System Requirements Document
UCLIM	UF_6 Cylinder Location, Inspection, and Maintenance
UF_6	uranium hexafluoride
USEC	United States Enrichment Corporation
WSS	Work Smart Standards

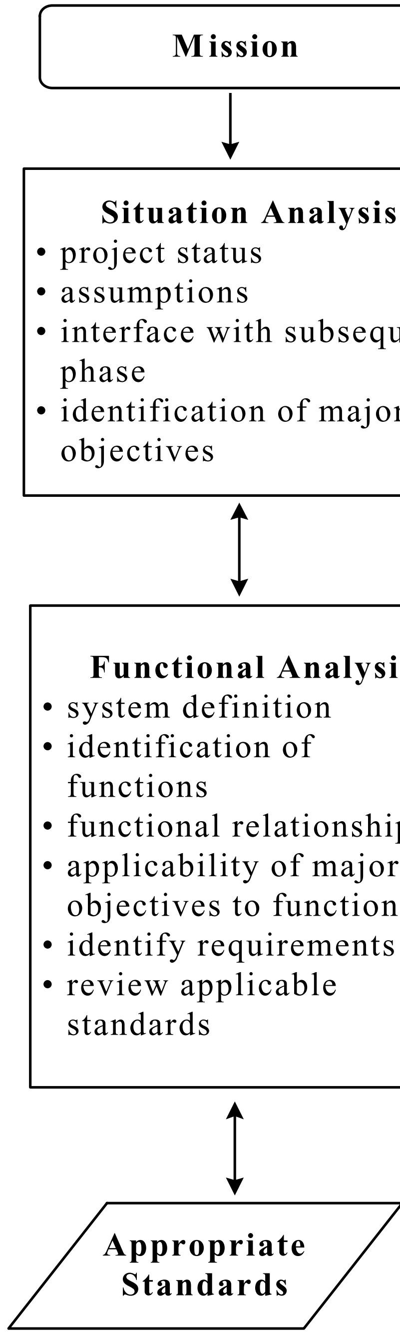
EXECUTIVE SUMMARY

The Department of Energy manages an inventory of uranium hexafluoride through the Uranium Hexafluoride Cylinder Project. The Project mission is to safely store the uranium hexafluoride inventory until its ultimate disposition. Bechtel Jacobs Company LLC., the managing contractor, is applying Systems Engineering principles to the Project to strengthen and integrate Project activities. This System Requirements Document is the first of four documents developed in the application of Systems Engineering principles to the Project. It contains the requirements necessary to achieve the Project mission and illustrates the rationale and intent of the requirements and the applicable standards.

This document will be used in the decision-making process to determine necessary Project activities for compliance with the stated requirements. The decision-making process will be documented in the Systems Engineering Management Plan, the next in the series of documents associated with the application of Systems Engineering principles to the Project. The requirements and rationale herein will be updated as the Project generates new information and the standards governing the Project change.

This System Requirements Document specifies the requirements for the Project during its current storage phase, and it provides the initial segment of the flow-down process, to demonstrate that the system used to achieve Project objectives complies with applicable standards. The requirements apply to both technical and management aspects of the Project. During development of the requirements, consideration was given to maintaining the flexibility in subsequent phases of the Project, which include dispositioning of the depleted uranium hexafluoride and decommissioning of the facilities and equipment. The requirements were identified through three steps as illustrated in the following figure.

- **Situation Analysis**: Major objectives for the Project were developed by articulating the current configuration of the system, reviewing the situation to determine focus areas that are necessary to meet the mission, and delineating and verifying baseline considerations and assumptions. These major objectives provide the frame work for a risk management strategy to direct the Project activities.
- **Functional Analysis**: The system used to meet Project objectives was defined in terms of components and activities for various operational states, (e.g., routine and off-normal), which are described in four operational functions. These four operational functions are: (1) surveillance and maintenance, including maintenance coating; (2) handling and stacking; (3) contents transfer UF_6 contents; and (4) off-site transport. The key relationships between these functions were also specified. The operational functions were compared to the major objectives to determine the system and technical requirements for successfully meeting the Project mission. To complete this functional analysis, the standards (applicable Department of Energy Orders, federal regulations, industry codes, etc.) necessary to manage hazards within the Project were identified and traced to Project requirements. Deviations from applicable standards are fully addressed, to ensure safe operation.



CYLFIGSP.PPT

Requirements development process.

1. SCOPE

This section describes the application of Systems Engineering principles to the storage phase of the UF_6 Cylinder Project. In particular, this defines the development and application of system requirements.

1.1 PURPOSE

The requirements listed in this document define the basis for actions necessary to achieve the Project mission.

1.2 SYSTEM OVERVIEW

1.2.1 Mission

The UF_6 Cylinder Project mission is to safely store the UF_6 inventory until its ultimate disposition. The average ages of cylinders in storage ranges from 20 to 29 years. Much of this UF_6 inventory has been stored for many years without adequate surveillance and maintenance of facilities sufficient to meet the current Project mission; therefore, actions to improve the storage system are critical to a viable system.

The next phase of the Project, dispositioning the UF_6 inventory, is under development. The final phase, decommissioning of the facilities, will be integrated into the decontamination and decommissioning of the diffusion cascades at the aforementioned sites. The System Requirements Document (SRD) does not encompass the requirements for these subsequent phases. However, the SRD does establish the interface between the storage phase and these subsequent phases, including the impact on requirements stated herein. These interfacing requirements establish continuity for the Project and its system to transition to subsequent phases.

1.2.2 Background

The Department of Energy (DOE) owns an inventory of uranium hexafluoride (UF_6) nominally less than 5% enrichment. This inventory is managed by the UF_6 Cylinder Project. The bulk of the DOE inventory is 560,000 metric tons of depleted UF_6 (DUF_6) produced by the gaseous diffusion plant enrichment process while the plants were operated by DOE and its predecessors. The balance of the inventory is normal assay and low-enriched assay UF_6 contained in cylinders.

The inventory is stored as a crystalline solid principally under vacuum. The DUF_6 is stored primarily in 48-inch-diameter steel cylinders with capacities of 10 or 14 tons. Typical cylinders are 5/16-inch-thick pressure vessels that were designed and manufactured to the American Society of Mechanical Engineers (ASME) code.[1] The cylinders are maintained at three sites: the Paducah Gaseous Diffusion Plant (PGDP), in Paducah, Kentucky; the Portsmouth Gaseous Diffusion Plant (PORTS), in Piketon, Ohio; and the East Tennessee Technology Park (ETTP), formerly known as the K-25 Site, in Oak Ridge, Tennessee. The inventory of cylinders containing DUF_6 is distributed at the three sites as follows: 28,400 cylinders at PGDP; 13,400 cylinders at PORTS; and 4,700 cylinders at ETTP.

After significant inventory of DUF_6 was produced from the enrichment process, outdoor storage facilities evolved independently at the sites. Cylinder yards were constructed of either concrete or compacted gravel, and cylinders were stacked in two-tiered rows on wooden or concrete saddles. The handling equipment used to stack these cylinders in two-tiered rows has also evolved, from mobile cranes to specially designed tractors that grasp and lift the cylinders with hydraulically actuated tines.

Until 1990, surveillance of the DUF_6 consisted of an annual nuclear materials inventory of the cylinders. The ETTP cylinder yards were surveyed in May 1990 to provide input for planning long-term corrosion monitoring of cylinders. Cylinder valves with corrosion and evidence of potential valve leakage were discovered. A June 1990 survey of valves of cylinders at PORTS revealed two cylinders with breached side walls. Investigation of these cylinder breaches determined that the causes were mechanical tears caused by impact from the lifting lugs of adjacent cylinders.[2] Subsequent inspections of stored DUF_6 cylinders revealed four breached cylinders at the ETTP. Two breaches were attributed to handling damage, and two were most likely initiated by external corrosion resulting from substandard storage conditions.[3] Another breached cylinder resulting from handling damage was discovered at PGDP.

The risk to personnel health and safety, and the potential environmental impact, posed by these cylinder breaches and valve leaks has been low, by nature of the system. The UF_6 inventory is stored as a solid. Reaction deposits formed when UF_6 is exposed to the atmosphere in the presence of the mild steel containers have a self-sealing nature. The bulk of the inventory is depleted in the fissionable isotope of the UF_6 such that the hazard is mostly chemotoxic, not radiological. These factors contribute to the low risk incurred from these and potential additional failures. This low risk was confirmed by analysis of the air and soil samples collected near the breaches at PORTS and by subsequent weighing of the cylinders. Although the risk posed by these breaches is low, the existence of breached cylinders heightened the importance of a comprehensive, long-term three-site cylinder management program. Consequently, in 1992, a cylinder integrity management plan was developed to address concerns within the storage yards and to establish the initial premise of the Project today.[4]

On May 5, 1995, the Defense Nuclear Facilities Safety Board (DNFSB) issued to DOE a recommendation regarding the storage of depleted UF_6 in cylinders.[5] The recommendations are summarized as follows:

- Start an early program to renew the protective coating of cylinders containing the tails from the historical production of enriched uranium.
- Explore the possibility of additional measures to protect these cylinders from the damaging effects of exposure to the elements, as well as any additional handling that may be called for.
- Institute a study to determine whether a more suitable chemical form should be selected for long-term storage of the depleted uranium.

On June 29, 1995, DOE accepted Recommendation 95-1 [5] and emphasized five focus areas for DOE response:

- removing cylinders from ground contact and keeping cylinders from further ground contact;
- relocating all cylinders into adequate inspection configuration;
- repainting cylinders as needed to avoid excessive corrosion;
- updating handling and inspection procedures and site-specific Safety Analysis Reports (SARs); and
- completing an ongoing study that will include an analysis of alternative chemical forms for the material.

On October 16, 1995, DOE submitted an Implementation Plan[6] that incorporated completed and near-term activities in accordance with these five focus areas. The Implementation Plan[6] also committed to managing the UF_6 Cylinder Project using a Systems Engineering approach. The approach was developed concurrent with field response activities and was enhanced through an open dialogue among DNFSB staff and personnel from DOE and Lockheed Martin Energy Systems, Inc. (LMES). The Implementation Plan[6] specifies the following interim and final deliverables and defines their respective content to establish an operative Systems Engineering process for the continued improvement of depleted UF_6 management through the UF_6 Cylinder Project. The deliverables are:

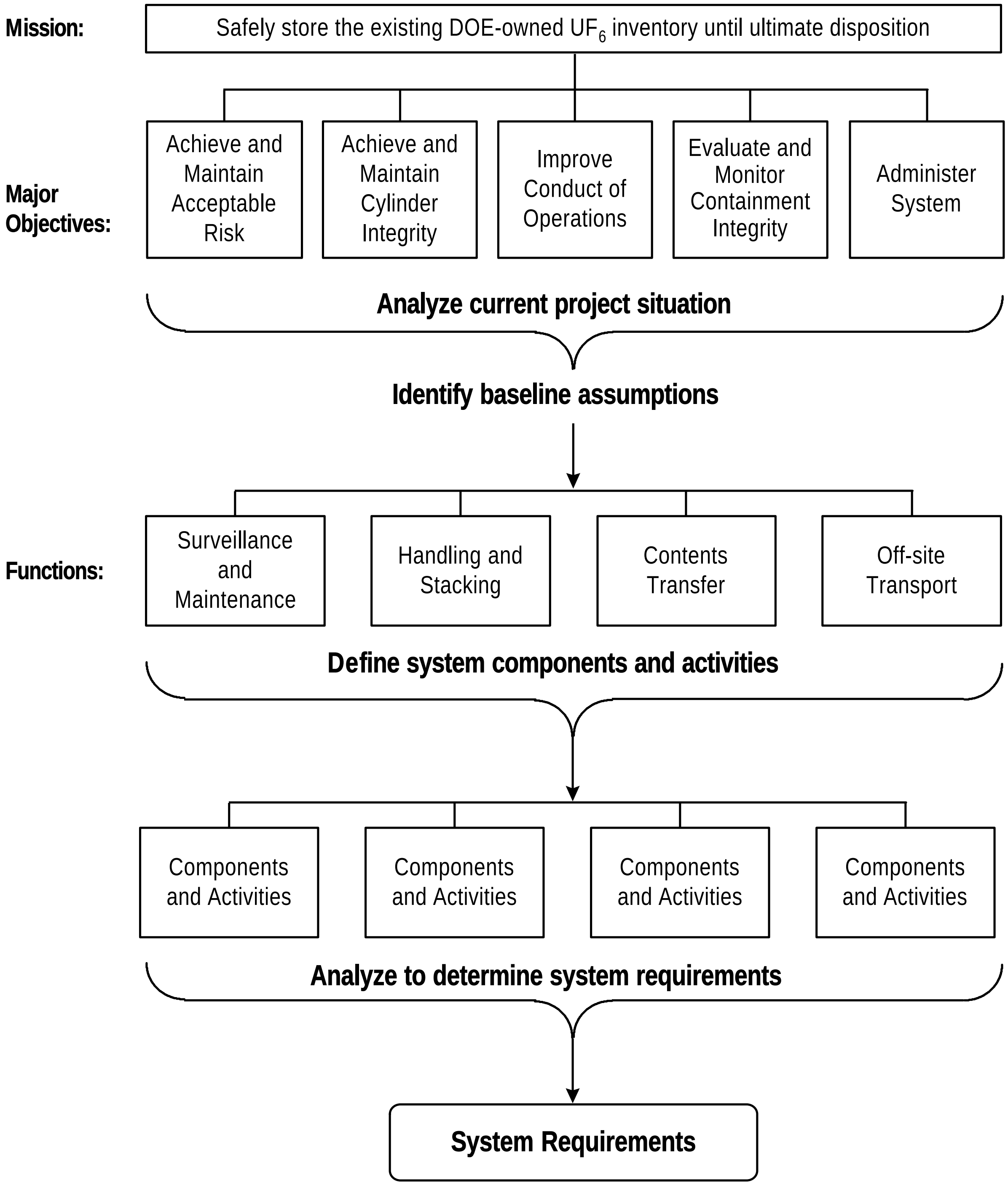
- System Requirements Document (SRD);
- System Engineering Management Plan (SEMP);[7]
- Engineering Development Plan (EDP);[8]
- UF_6 Cylinder Project Management Plan (PMP);[9] and
- Approved SARs.[10, 11]

1.3 ORGANIZATION AND DESCRIPTION

1.3.1 Development

The storage phase is ongoing, and the development and implementation of Systems Engineering runs concurrent with the existing activities. Aspects of the current Project are evaluated from a Systems Engineering perspective and modified as the evaluation dictates.

Development of the SRD necessitated an analysis of the current system functions and their current configuration. This analysis is graphically depicted in Fig. 1.1. In preparation for functional analysis, the current configuration of the system was articulated in a situation analysis. Major objectives for the Project were developed from the situation analysis in keeping with the Project



CYLFIGSP.PPT

Fig. 1.1. Development of system requirements.

mission. In support of the major objectives, the Project was bound by delineating and verifying baseline considerations and assumptions.

To initiate the functional analysis, the functions of the storage phase [surveillance and maintenance (S&M), handling and stacking, contents transfer, and off-site transport] were defined in terms of respective components and activities. These components and activities include hardware, personnel, command media or documentation, support functions, system activities, and interfaces with organizations regulating and performing the activities. The components and activities for each function were identified for relevant operational states including start-up, shutdown, routine, and off-normal. The interrelations among these functions were delineated, and the interface of the current phase of the Project (storage) with subsequent phases was evaluated. This later evaluation was performed to ensure flexibility and success in the dispositioning and decommissioning phases of the Project.

To complete the functional analysis and determine the system and technical requirements for successfully executing the Project mission, the defined operational functions were evaluated in the context of the major objectives. In many cases requirements are grouped into categories facilitating the rationale and intent of the requirements. Where applicable, DOE Orders, regulations, industry codes, and standards that govern these requirements are referenced. Deviations from applicable standards are fully identified to ensure safe operations. This process reflects the adaptation of Systems Engineering into an existing system, where many activities within the system are defined and underway.

1.3.2 Requirements Structure

Requirements are identified as either system-level requirements or subordinate, technical requirements. The compilation of system requirements represent a comprehensive listing of essential characteristics the system must maintain to accomplish the Project mission. The technical requirements provide specificity to the system requirements where needed to ensure actions are fully compliant with the intent of the system requirement. Standards are identified for system and technical requirements.

The requirements are documented where specific rationale logically dictates the need for a requirement. The purpose for listing requirements immediately following the rationale is to clearly show the development and intent of each system requirement and facilitate its application in the SEMP. Applicable standards and governing documents for specified requirements are identified in [*brackets*] following each requirement. The extent to which these standards are followed is limited to the scope of the requirement. The [*brackets*] are the means for locating requirements in the body of this document. Where a requirement, as specified by [*brackets*], does not have an applicable standard or governing document, the standard is considered to be managed within the Project. These standards are denoted in the text by [*Derived*]. Requirements identified in the situation analysis and functional analysis are captured in the requirements listed in Sect. 5. An example of a requirement and applicable standards is provided below.

2.3.3.b Methods for processing non-compliant cylinders shall be established as necessary [10 CFR 830.120, 10 CFR 835, DOE 5480.23]

2. APPLICABLE STANDARDS

The DOE initiated the Work Smart Standard (WSS) process to develop standards for activities managed by the Environmental Management and Enrichment Facilities business unit. The UF_6 Cylinder Project was one of three WSS projects undertaken as a Phase I effort. Based upon a clearly defined scope of activities, hazards and applicable standards were identified which were judged to be necessary and sufficient to protect the workers, the public, and the environment. With the approval of this set of WSS, previously approved ES&H Standards Requirements Identification Documents (S/RIDs) were replaced.

Since the approval of the Cylinder Project WSS, additional WSS sets have been approved that apply to the Cylinder Project activities. These additional standards consist of the set of WSS for engineering design and construction and the Phase II set of WSS which were developed to cover all remaining EM&EF activities. Appendix A of this document lists the complete set of ES&H WSS for the UF_6 Cylinder Project. The Work Smart process was implemented in accordance with the DOE closure process for Necessary and Sufficient sets of standards. This process is based on a detailed job analysis of the field work, and the identification of hazards encountered in the process of the work.

Review of the Systems Requirements and WSS indicated other pertinent standards were required for the UF_6 Cylinder Project. A list of these standards is provided below. Additional standards and refinement of existing standards will continue to be required during the life of the Project. Additional standards and modifications to existing standards will be accomplished through the Systems Engineering Process.

1. DOE 4700.1, *Project Management System*.
2. DOE 5400.1, *Environmental Protection*
3. DOE 5480.7A, *Fire Protection*
4. DOE 5480.19, *Conduct of Operations*
5. DOE 5480.31, *Startup and Restart of Nuclear Facilities*
6. DOE 5633.3B, *Control and Accountability of Nuclear Materials*
7. DOE 6430.1A, *General Design Criteria,* including all applicable regulatory requirements referenced in Section 0106 and all references standards and guides in Section 0109
8. USEC-651, Rev. 7, *Uranium Hexafluoride: A Manual of Good Handling Practices,* January 1995
9. Directors Findings and Orders (DFO), State of Ohio Environmental Protection Agency
10. ANSI N14.1, *Uranium Hexafluoride - Packaging for Transportation*

Appendix B provides an allocation of all applicable standards (WSS and those provided in Sect. 2) to the twelve requirements categories shown in Figure 5.1. The extent to which applicable standards are followed is limited to the scope of the corresponding requirement.

3. SITUATION ANALYSIS RESULTS

This section provides the rationale for development of the Project's major objectives. The major objectives are established to focus the management of the Project on key aspects necessary to meet the Project mission. These objectives stem from an understanding of: (1) the current status of the Project used to achieve Project objectives, (2) the interface of the storage phase (current phase) with subsequent phases (UF_6 disposition and decommissioning of the storage facilities and equipment), and (3) the bounding assumptions for the Project. To complete the situation analysis, the major objectives are identified and defined for application in the functional analysis used to determine the necessary requirements of the system.

3.1 PROJECT STATUS

This section states the current understanding of the condition of the Project, including known deficiencies and concerns, and actions taken to date to reduce the risks within the Project. A number of general and specific system problems and deficiencies have been identified through self-assessments and improvements in management practices have been made. Conditions and factors that have contributed to the causes date back to when DOE and predecessor agencies began placing DUF_6 in storage. The fundamental cause is that a risk analysis for the UF_6 Cylinder Project was not adequately documented. Additional contributing causes include the absence of a defined life-cycle cylinder maintenance project, lack of appropriate resource application at the onset of long-term storage, lack of adequate operational controls used to place cylinders in their current locations, inadequate integration of system operations, and absence of a well-defined mission leading to the ultimate disposition of DUF_6 stored in cylinders.

These past management deficiencies have resulted in the following conditions:

1. A number of cylinders were permitted to remain for extended periods in ground contact and in storage yards where drainage was not maintained. This condition, in conjunction with no maintenance of a protective coating, has resulted in accelerated corrosion of cylinder bodies and the through-wall corrosion (failure) of two cylinders. The mild steel composition of the cylinders corrodes at an accelerated rate during extended periods of wetness.
2. Before 1990, the system did not include cylinder surveillance, which allowed the cylinders and storage conditions to deteriorate without updated characterization. This lack of characterization resulted in the unmitigated continued storage of breached cylinders, cylinders with leaky valves, cylinders with loose or detached nameplates, and the continued use of safety documentation that did not reflect current cylinder conditions.
3. Handling and stacking procedures and operations before 1990, resulting in the current storage configuration, are the cause of stacked cylinder arrays with insufficient spacing to facilitate inspection, configurations with less-than-desirable cylinder support, the impact failure of five cylinders, and other physical damage to the cylinders and protective coatings.

Many specific deficiencies have been identified concerning the long-term storage facilities and the cylinders. This section states the deficiencies identified to date and prioritizes them relative to risks. Further characterization and evaluation of risks will revise this prioritization. Prioritizing deficiencies is used in the optimization of actions taken to reduce risks within the Project.

Existing and potential deficiencies are listed in Table 1. The data provided in Table 1 are best estimates to be used in determining the extent of needed improvements. The primary source of the data is the UF_6 Cylinder Location, Inspection, and Maintenance (UCLIM) data base with adjustments for improvements made to date. The deficiencies are categorized as follows:

Category A: Direct Container Integrity Concerns
Category B: Storage Facility Concerns
Category C: Uranium Control Issues
Category D: UF_6 Transfer Issues
Category E: Other Issues

Categories A, B, and C (Direct Container Integrity Concerns, Storage Facility Concerns, and Uranium Control Issues) are given priority over categories D and E (UF_6 Transfer Issues, and Other Issues). Categories A, B, and C have a potential to result in an undesirable occurrence while these cylinders are being used as long-term storage vessels, such as a release of uranium could occur, or the handling of mistaken uranium assays could result [i.e., depleted uranium (DU) thought to be normal or enriched and vice versa]. Within the three priority categories, highest priority is given to breached cylinders, substandard facilities, and non-DU material deficiencies (A1, B1, and C1, respectively). An occurrence from these deficiencies is considered the most serious. Category D, UF_6 Transfer Issues, applies to the removal of the UF_6 from the subject containers and is relative to the subsequent UF_6 dispositioning phase of the Project. Categories A, B, and C are also applicable to the disposition phase of the project. Category E, Other Issues, is relative to best management practices in keeping with the long-term, safe storage of UF_6.

The highest priority is given to identifying and controlling breaches to minimize the release of uranium compounds and potential environmental insult or exposure (i.e., to Category A1). Identifying and controlling breaches also minimizes the criticality concerns with fissionable assays of material. A lesser priority is given to repairing or replacing cylinders. Until final resolution can be accomplished, patched breaches are periodically inspected and provisions are made to prevent any spread of uranium contamination from the cylinder.

Breaches can occur by any of three mechanisms: mechanical impact, external corrosion, or rupture from over pressurization. Other failure mechanisms, such as internal corrosion, have not proven to be realistic mechanisms within the scope of the storage project. However, further study may be warranted. Five breaches by impact from adjacent cylinders during stacking and two breaches by external corrosion have been identified. The investigation into the exact circumstances causing the breaches has provided information crucial to the management of long-term storage cylinder integrity. Cylinder rupture due to over pressurization requires a significant energy source (heat or internal pressure). No cylinder within the DOE complex has been accidentally ruptured from over pressurization; however, a cylinder has accidentally ruptured within the U.S. UF_6 industry.

Table 1. Long-term Storage Inventory Potential Deficiencies

	Background Potential Deficiencies	Estimated Number of Cylinders Affected
A	**Direct Container Integrity Concerns**	
A1	Breached cylinders - cylinders with holes in the cylinder shell	7[a]
A2	Corroded cylinders - cylinders with visible pitting and/or scaling rust	22,000
A3	Leaking valves - valves and plugs that have recurring contamination	10[b]
B	**Storage Facility Concerns**	
B1	Substandard Facilities - sinking or poorly drained load-bearing surfaces	15,300
B2	Improper Support - upper tier cylinders supported by unsound points of contact	920[c]
C	**Uranium Control Issues**	
C1	Non-Depleted Material - normal and enriched material located in DU storage facilities	2,300
C2	ID Plates - loose or detached identification plates	4,000
D	**UF_6 Transfer Issues - cylinders that do not pass the inspection criteria established in USEC-651 for liquid transfer**	
D1	Fill-Limit Consideration - cylinders without certified internal volumes or cylinders filled above the current maximum allowable limit established in USEC-651[d]	42,900
D2	Substandard Valves - valves with missing or cracked parts, Teflon tape on threads, bent stem, and/or improper engagement	12,000
D3	Plug Replacing Valves - plugs in place of valves	2,200
D4	Physically Damaged Cylinders	20,000
D5	Cylinder Design hindrances- cylinders that will not fit into currently designed autoclaves	290
E	**Other Issues- cylinder may have more than one potential deficiency**	
E1	Inaccessible Cylinder - cylinders that cannot be accessed at both heads for a visual inspection	11,000
E2	Above Internal Vacuum - cylinders with internal pressure above atmospheric conditions	5,000

[a]All breached cylinders have been permanently or temporarily patched.
[b]Leaking valves have been mitigated.
[c]Improperly supported cylinders have been mitigated by engineered controls.
[d]Could be off-site transport compliance issues.

An overfilled cylinder was heated during a routine feeding operation. The investigation of this incident identified several contributing causes including the lack of recognizing the cylinder excessive weight, heating a closed system (closed valve), and a crude heat source control system. Excessive pressure has been experienced in the complex with a 30A model cylinder when, after filling with liquid UF_6 and set aside to cool, a detonation occurred resulting in a deformed cylinder. Investigation of this occurrence determined a UF_6/hydrocarbon exothermic reaction caused the over pressurization. The source of the hydrocarbon was identified as oil from a vacuum pump used in the cylinder cleaning operations. Both of these over pressurization occurrences have resulted in additional preventive controls for the emptying and feeding operations of cylinders.

Corroded cylinders, Category A2, are a product of external accelerated corrosion due to the design of the cylinder or due to its physical placement, (e.g., a skirted cylinder or cylinders in ground contact). The estimated number of cylinders for Category A2 does not include cylinders with degraded or absent protective coatings that atmospheric corrosion has affected. The protective coating is applied to provide an initial protection against rusting and it degrades with the aging of the cylinder or deficient cylinder handling. In addition to the protective coating, the cylinder shell thickness is designed with a minimum of 50 mils of corrosion allowance. Atmospheric corrosion (less than 1 mil per year reduction in wall thickness) is visually identified by a uniform rust-coated surface without scale or pits. The rate of shell thickness reduction from accelerated corrosion can vary greatly from general atmospheric corrosion rates.

Continued use of corroded cylinders will be subject to the scrutiny of the functional acceptance criteria and of possible corrective actions to be developed. The oldest design models include the 10-ton Model T, the 14-ton Model O, and 2½-ton 30A cylinders. These cylinders have been in storage the longest period of time without protective coatings and in areas not adequate for long-term storage. The criteria will determine if a corroded cylinder is unsafe for continued use. If the cylinder requires a maintenance coating, the shell surface will be prepared and a rust-protective coating will be applied. If a cylinder is unsuited for continued storage, as determined by the functional acceptance criteria, it will be placed in a queue for transfer of its contents to another cylinder via to-be-established feed procedures for defective cylinders.

Without the application of a protective coating or a change in the corrosive environment, cylinders that exhibit heavy scaling rust or pitting-type corrosion will continue to corrode at an above-normal rate, and their life expectancy will be reduced considerably from the projections based on general atmospheric corrosion rates. Scaling rust and pitting corrosion are results of extended periods of wetness imposed on the cylinder shell. Once initiated, the pits and scale, without proper maintenance, will continue to facilitate water retention. Extended wetness can occur on cylinders that retain rainwater as a result of design or on cylinders that remain in ground contact or in poorly drained yards. Cylinders that by design retain rainwater are cylinders with skirts and cylinders with channel- type stiffening rings. Although drain holes can be provided where water would collect, proper drainage can be obstructed by rust and foreign material or improper cylinder stacking orientation. Maintenance to ensure these drain holes stay clear is necessary.

Leaking valves and plugs, Category A3, have a potential to release small quantities of uranium. Leaks can to some extent be identified visually by recurring contamination. Leaks can be verified by an HF monitor and/or a radiation contamination survey. Leakage will be contained by tightening the valve/plug or by replacing the valve/plug. To date, valves verified as leaking have been mitigated.

Substandard facilities, Category B1, consist of yards that permit extended periods of wetness on cylinder surfaces due to poor drainage or settling to the extent that cylinders contact the ground. Cylinders on the bottom tier under these conditions corrode at the six o'clock position at an accelerated rate as discussed in Category A2. The corrective action is to remove these cylinders from substandard conditions as soon as technically feasible and either renovate the yard to meet current standards or no longer use the yard as a storage facility. PGDP yards C-745-F and C-745-G, which contain about 12,000 cylinders, have been identified as substandard storage facilities. Other yards within the three sites have been identified as having sporadic substandard conditions. In these cases, subjected cylinders will be removed and placed in proper storage yards. This effort is underway. G yard has been renovated, F yard has been mitigated.

Improper support, Category B2, consists of upper-tier cylinders that are not soundly supported by the bottom-tier cylinders because of improper placement (e.g., a narrow-stiffening-ring to narrow- stiffening-ring support or support from a lifting lug). These cylinders present a concern in the event of an earthquake, when an improperly supported cylinder could be dislodged and fall freely for a few inches to a new resting position. Structural analysis has determined that the subject cylinders may become breached from this free fall, and a safety evaluation has determined the impact from these possible breaches. The safety evaluation indicates mitigating these conditions is not required, however, it should be considered a best management practice. As of February 28, 1997, the subject cylinders have been restacked or chocked to prevent movement during a seismic event.

Non-depleted uranium, Category C1, is defined as cylinders that contain natural and enriched material which are located in the DU storage facilities. Adequate uranium control is necessary to ensure that cylinders containing non-DU are not mistaken for cylinders containing DU and vice versa. All sites have a Nuclear Material Control and Accountability (NMC&A) organization that requires that the cylinder contents, including assay, are verified by records before the cylinder is serviced, processed, or shipped off site. Cylinders containing fissionable material are managed according to Nuclear Criticality Safety Analysis standards.

Cylinders with loose, detached, or missing cylinder identification (ID) plates, Category C2, are another uranium control issue. Identification plates become loose or detached because of corrosion facilitated by moisture retention between the plate and the cylinder shell and by the dissimilar metals, stainless steel plate, and the mild steel shell. Loose and detached ID plates are occurring on the oldest cylinders in storage. National Board Inspection Code (NBIC) guidelines require that the original fabrication documentation be in-hand before ID plates are reattached. If the documentation can be obtained, ID plates will be reattached; if not, tags will be fabricated and attached. As minimum requirements, the replacement tags will indicate they are replacements and will give the cylinder identification number. Authorization to reattach tags will be documented and signed by appropriate personnel. Documentation will remain in the cylinder history file as long as the cylinder is in service.

Table 1 lists five existing and potential deficiencies in Category D that are relative to material transfer operations. These deficiencies are not necessarily applicable to existing and long-term storage given the boundary assumptions provided in Sect. 3.3. These five potential deficiencies are: (1) fill-limit consideration, (2) physically damaged cylinders, (3) substandard valves, (4) plug replacing valve, and (5) cylinder design hindrances. Additional constraints on transfer operations are included in categories A, B, and C. Transfer Issues also include the potential presence of hydrocarbon oil in the cylinder. Some cylinders were filled before use of the improved vacuum pump design, which eliminated the source of the hydrocarbon oil. Hydrocarbons and UF_6 produce an exothermic reaction. Mitigation of these potential deficiencies will be addressed as necessary in the control of the UF_6 transfer operations.

Table 1 defines the two other existing and potential deficiencies relative to long-term storage. These are: relocating inaccessible cylinders so that a more thorough visual inspection can be conducted and establishing an internal vacuum to ensure the integrity of the UF_6 contents. These potential deficiencies will be addressed accordingly through a cost-benefit optimization. No actions are underway to reduce the internal pressure when it is above atmosphere unless the cylinder is identified for off-site transport. Currently, cylinders are being respaced for adequate inspection.

3.2 INTERFACE WITH SUBSEQUENT PHASES

No significant design and configuration changes within the system that would incrementally impact the decommissioning of cylinders, storage facilities, and equipment are anticipated. Current plans require the reconstruction of substandard facilities, to mitigate unacceptable conditions. However, if regulation changes (external governing documents) or cylinder conditions necessitate a configuration change, the incremental impact on the decommissioning phase could be significant. Examples of this potential impact include: (1) the need for additional precautions to protect against environmental exposure, (2) more prescriptive cylinder access requirements, and (3) the establishment of cylinder standards for storage only (disassociated with transport standards). These examples could dictate a change in configuration such that indoor storage, single cylinder spacing, or mass cylinder replacements are considered. These options would impact the decommissioning phase with the consumption of additional real estate for storage, and the radioactive contamination of additional mild steel (i.e., the need for new cylinders). Impact on the subsequent dispositioning and decommissioning phases of the Project will be considered when developing actions to accommodate regulation changes under the current storage phase. [10 CFR 830.120]

The greatest incremental impacts on the decommissioning phase from current operations include decontamination and environmental remediation. These aspects are closely related when considering the current system. Support organizations provide oversight for compliance with requirements for contamination control. Environmental remediation is impacted primarily by degree of containment integrity. Containment integrity is a major element within the storage phase, and the requirements for such are specified in Sect. 5.4. Environmental monitoring in the current phase will be assessed to ensure the establishment of additional actions, if any, beyond current activities that are necessary to maintain compliance with applicable orders and regulations. Additional activities will be established such that environmental monitoring actions within the storage phase are balanced with potential environmental remediation in the decommissioning phase.

Operations within the current storage phase require a significant interface with the dispositioning phase currently under development. The condition of the cylinder will greatly influence the flexibility of the dispositioning phase (i.e., normal off-site transport and normal transfer of the contained UF_6). Deteriorated cylinders limit this flexibility. The cylinder contents also have some impact on the flexibility of the dispositioning phase. For example, the purity of the contents, the mass, and the internal pressure can impact the dispositioning operations. It is expected that the condition of a portion of the current cylinder inventory does not meet the minimum standards of Department of Transportation (DOT) and American National Standards Institute (ANSI) for off-site transport. However, the off-site transport of these cylinders for dispositioning is not a requirement at this time. As a contingency, engineering studies will evaluate the conditions of these cylinders and will propose solutions to the transportation and transfer operational constraints. In addition, the planning for UF_6 dispositioning is taking into consideration the condition of cylinders and necessary actions to accomplish disposition operations. [49 CFR, 10 CFR 830.120]

3.3 BASELINE CONSIDERATIONS AND ASSUMPTIONS

The following considerations and assumptions are provided to bound the scope of Systems Engineering. Many of these assumptions are current working assumptions that will be modified through developments defined in the EDP. The current working assumptions are identified as such to integrate the Systems Engineering approach with the current system.

1. *Risks are managed within the current system.* This assumption permits the Project to continue planned operations concurrent with the safety analysis upgrade as authorized under the current safety basis. Planned operations are necessary to correct substandard conditions. This assumption does not preclude the Project from pursuing reduction of risks.

2. *Effective risk management for handling degraded cylinders will not appreciably impact planned costs and relocation timing.* This statement assumes the degraded cylinder handling risks are accounted for in recent procedure improvements. Functional acceptance criteria under development will not necessitate additional controls that impact cost and timing of planned operations. This assumption is integrated into budget planning for cylinder handling operations.

3. *Current yard construction will result in storage surfaces with acceptable time of wetness.* This assumption permits the progression of yard construction while the definition of unacceptable/acceptable extended time of wetness is under development. Current design of yards derived from general outdoor construction standards is thought to be acceptable.

4. *Corrosion rates are variable and cylinder specific.* This statement is substantiated by the failure of two cylinders at the ETTP from external corrosion and the lack of thickness data obtained to date on other cylinders below 0.14 inches. This statement limits the extrapolation

of wall thickness data to other cylinders. A statistical sampling plan will be used to characterize the condition of cylinder populations and make decisions on needed improvements and planning of the disposition phase.

5. *Skirt corrosion necessitates priority corrective measures.* This assumption is based on limited thickness data collected, corrosion products collected from cylinder skirts, and subsequent projected rates of corrosion. This assumption substantiates the expedited implementation of cleaning and coating skirted regions prior to whole body painting.

6. *As more data are gathered through nondestructive analyses, structural analyses, visual inspections, valve monitoring, and experiences with failed cylinders, the majority of cylinders will be shown to comply with industry standards; the condition of those cylinders that do not meet industry codes will be shown to present no imminent danger.* This assumption permits the near term storage of the DUF_6 in existing cylinders instead of the alternative configurations such as replacement of cylinders, restoration of cylinder thickness, or acceleration of the DUF_6 disposition phase.

7. *Cylinders to be replaced will be accommodated with existing transfer capabilities at PORTS.* This assumes that only a small number of cylinders will need to be replaced, that United States Enrichment Corporation (USEC) continues to be interested in this work, and that NRC and the Ohio Environmental Protection Agency permit these type of operations at PORTS. PGDP's application for NRC certification did not include this type of operation. If the PORT's USEC option is terminated and this assumption changes, development activities will need to be initiated to establish a viable contents transfer alternative to support the system's need for this function.

8. *Compliance with ANSI N14.1 is not necessary for continued safe storage of cylinders*. The impact of this assumption is minor within the current phase. However, the assumption limits the flexibility and economics of the subsequent phases because ANSI N14.1 is applicable for shipment of cylinders. The validation of this assumption requires the evaluation, determination, and approval of functional acceptance criteria and a viable means to transport cylinders subject to the ANSI standard or under a DOT exemption for foreseeable shipments.

9. *Cylinder contents purity is reflective of the statistical sampling and analysis completed at the time of filling.* This assumption permits the planning and implementation of the dispositioning phase based on statistical purity information and is sufficient for continued storage.

10. *Cylinder contents reflect the NMC&A database records*. This assumption permits verification for shipment of cylinders in compliance with DOT requirements where a means to weigh cylinders for accountability is not available.

11. *The majority of X-745-C and K-1066-E yards are acceptable for continued use*. This assumption permits the continued planned use of these yards while storage criteria are under development.

12. *Cylinders with inaccessible plug ends do not require immediate priority action to verify containment integrity.* This assumption is substantiated by the verified conditions of accessible cylinders and by the verified conditions of the recently moved inaccessible cylinders.

13. *DOE will continue to regulate the inventory of DUF_6.* This assumption is based on the recent status of negotiations with the Ohio Environmental Protection Agency on the regulatory jurisdiction of this inventory and enables DOE to continue to manage the inventory.

14. *Funding will be obtained to complete necessary activities as planned*. This assumption limits the amount of contingency planning necessary to ensure the mission will be successfully accomplished.

15. *The dispositioning phase of the DUF_6 inventory will be initiated in FY 2020 and progress at a rate of 3000 cylinders/year.*[12] *The cylinders of lesser integrity will be dispositioned first*. This assumption is used in determining the extent of corrective actions necessary and the degree of periodic maintenance implemented. This assumption is under review and will be revised through the programmatic environmental impact statement (PEIS).

16. *The coating operation will result in cylinder coating life of 8 to 10 years*. This assumption is supported by the literature reviews, solicited vendor experience, and the value engineering study conducted by the Project. This assumption will be used to size the coating capacity at each storage site and develop the surface preparation method. Accepting minor periodic maintenance of the coating is acceptable.

17. *Requirements for the Project that were not considered Project specific are maintained and managed at the site level and are not contained in this SRD.* The Project relies on the support organizations at each site to oversee adherence to applicable requirements and standards.

18. *Risks within the system will be prioritized and actions to reduce these risks will be optimized as practical.* The statement enables the Project to manage risks and risk reduction activities within the system.

19. *Cylinders will be kept in outdoor storage in current climatic regions until ultimate disposition of the contained UF_6*. This assumption is the basis for sub-recommendation 2, paint cylinders, of the DNFSB Recommendation 95-1.[5] This assumption may be validated with the outcome of the PEIS.

3.4 DEFINITION OF MAJOR OBJECTIVES

The major objectives of the storage project are promulgated from the situation analysis. The mission of the Project is to safely store the UF_6 inventory until its ultimate disposition. Current expectations are that the cylinders will continue to be used as storage vessels for the UF_6 material and the cylinders will remain in outdoor storage until ultimate disposition. To achieve this mission in light of the current situation, five major Project objectives have been formulated to assist in focusing and organizing various Project activities. These major Project objectives are:

1. Achieve and maintain acceptable risk.
2. Achieve and maintain cylinder integrity.
3. Improve conduct of operations.
4. Evaluate and monitor containment integrity.
5. Administer the system.

The objectives are intended to provide the framework for a risk management strategy for long-term storage of UF_6 in cylinders.

The following sections describe these major objectives and provide the rationale for their establishment.

3.4.1 Achieve and Maintain Acceptable Risk

This major objective ensures the Project remains focused on a risk management strategy to identify risks, control them, and to further reduce them as feasible. Other major objectives are considered sub-sets of this objective to achieve and maintain acceptable risk. Identified risks associated with the system used to meet the Project mission include: (1) radiation exposure, (2) contact with surfaces contaminated with radioactive material, (3) exposure to toxic materials resulting from the release of UF_6 and/or reaction products, (4) standard industrial hazards, and (5) an environmental insult caused by the release of UF_6 and/or reaction products.

DUF_6 contained in cylinders presents a low radiation risk. Dose rates are estimated to be 2 mrem per hour with hands-on cylinder work and 0.5 mrem per hour for persons performing general cylinder yard work. The remaining risks associated with the UF_6 Cylinder Project are related to the release of cylinder contents. Therefore, a key emphasis of the Project is to minimize risk by maintaining the containment integrity of the cylinders.

As stated in the mission, the Project strives for safe operations. In order to prepare for, establish, and conduct operations the associated risks to personnel, the public and the environment must be articulated. These risks are a product of the hazards within the system and the probability they will materialize. After the hazards are identified and risks are evaluated, determining the initiating events and consequences, measures are established to lesson the likelihood of occurrence. In addition, mitigative measures are also pursued to minimize consequences. These defensive measures can be in the form of design, engineering, and/or administrative controls. A graded approach to implementing defensive measures is taken to combat the severity of the risk recognizing design and engineering controls can provide greater assurance for protecting against initiating events and consequences.

3.4.2 Achieve and Maintain Cylinder Integrity

This objective reflects the storage phase of the Project and the primary risk associated with this phase. Because a primary event of concern is loss of containment, a major objective to mitigate deterioration and maintain or improve existing integrity is established. Consequences including personnel, the public, and the environmental exposure to UF_6 and reaction products, contamination, and exposure to elevated levels of radiation all have the common failure of loss of containment. This objective also stems from the lack of maintenance of cylinders and storage facilities in past years. This condition presents an elevated systemic risk to the Project. Mitigating deterioration of the cylinders, particularly during the storage phase of the Project, provides the greatest flexibility in the subsequent dispositioning phase.

3.4.3 Improve Conduct of Operations

Because the hazards within the storage phase are inherently low, the controls within the system to manage risks are primarily administrative controls. This objective addresses the rigor of these controls and their effectiveness in sustaining controlled risk. Administrative controls depend on the conduct of operations. Thus, conduct of operations is an integral portion of a safe system. Subsystems that provide accurate training, qualification, and work control including procedures, and procedure adherence comprise the essence of this major objective.

3.4.4 Evaluate and Monitor Containment Integrity of Cylinders

This objective also focuses on the current phase of the Project, storage of the UF_6 inventory. This objective defines and maintains a status of conditions and establishes the forecasting information to ensure success of the Project mission. This is accomplished by monitoring and evaluating cylinder and storage conditions, in addition to monitoring factors that degrade conditions for the purposes of forecasting. The monitoring of degradation factors establishes a proactive approach to potential system problems with containment integrity.

3.4.5 Administer the System

This objective is responsive to past deficiencies within the Project (a lack of applied resources) and to the expected duration of the cylinder storage phase (through 2020). Obtaining and utilizing resources (financial, capital, and intellectual) are necessary to sustain a viable storage system. This objective encompasses the optimization and integration of resources to provide an efficient system, and a system that is responsive to changes in standards, and the development of subsequent system phases (e.g., dispositioning the UF_6).

4. DESCRIPTION OF SYSTEM FUNCTIONS

4.1 FUNCTIONAL ANALYSIS PROCESS

The functional analysis defines the system functions, derives the requirements, and identifies the applicable standards to meet the major objectives of the Project (Fig. 1.1). In order to comprehensively determine the requirements for the Project, it is necessary to first identify the system functional activities and components within the start-up, routine, shutdown, and off-normal states of operation for the fundamental system roles of surveillance and maintenance, handling and stacking, contents transfer, and off-site transport.

The first task of the functional analysis was to define the system. A checklist method was used to define the system. This checklist method used key words to elicit the components and activities within the system at the various operational states. The key words used include: physical equipment, personnel, documents, support functions, and organization interfaces.

The next task was to analyze the activities and associated components for each major objective to identify requirements necessary to meet the major objectives. Practicability dictated that the functional analysis process involve not only cylinder Project management personnel and technical experts, but also subject matter experts from a broad range of other disciplines. Subject matter experts and their command media resources were relied upon to ascertain the applicability of orders, codes, and standards to the requirements. This methodology, which is depicted in Fig. 4.1, ensures that Project requirements appropriately translate into compliance with existing applicable orders, codes, and standards, and that they ultimately support follow-down into procedures. During the functional analysis process, requirements were categorized to enable discrimination of the rationale and intent of the requirements.

4.2 SYSTEM DEFINITION

The system established to meet the Project mission is the means by which containment is achieved. The system comprises components (such as the UF_6, cylinders, cylinder yards, cylinder-handling equipment, personnel, and financial resources) and activities (such as operations, management processes, and administration).

The system includes several operational functions to manage the containment integrity of the cylinders. These operational functions are:

- Surveillance and Maintenance,
- Handling and Stacking,
- Contents Transfer, and
- Off-site Transport.

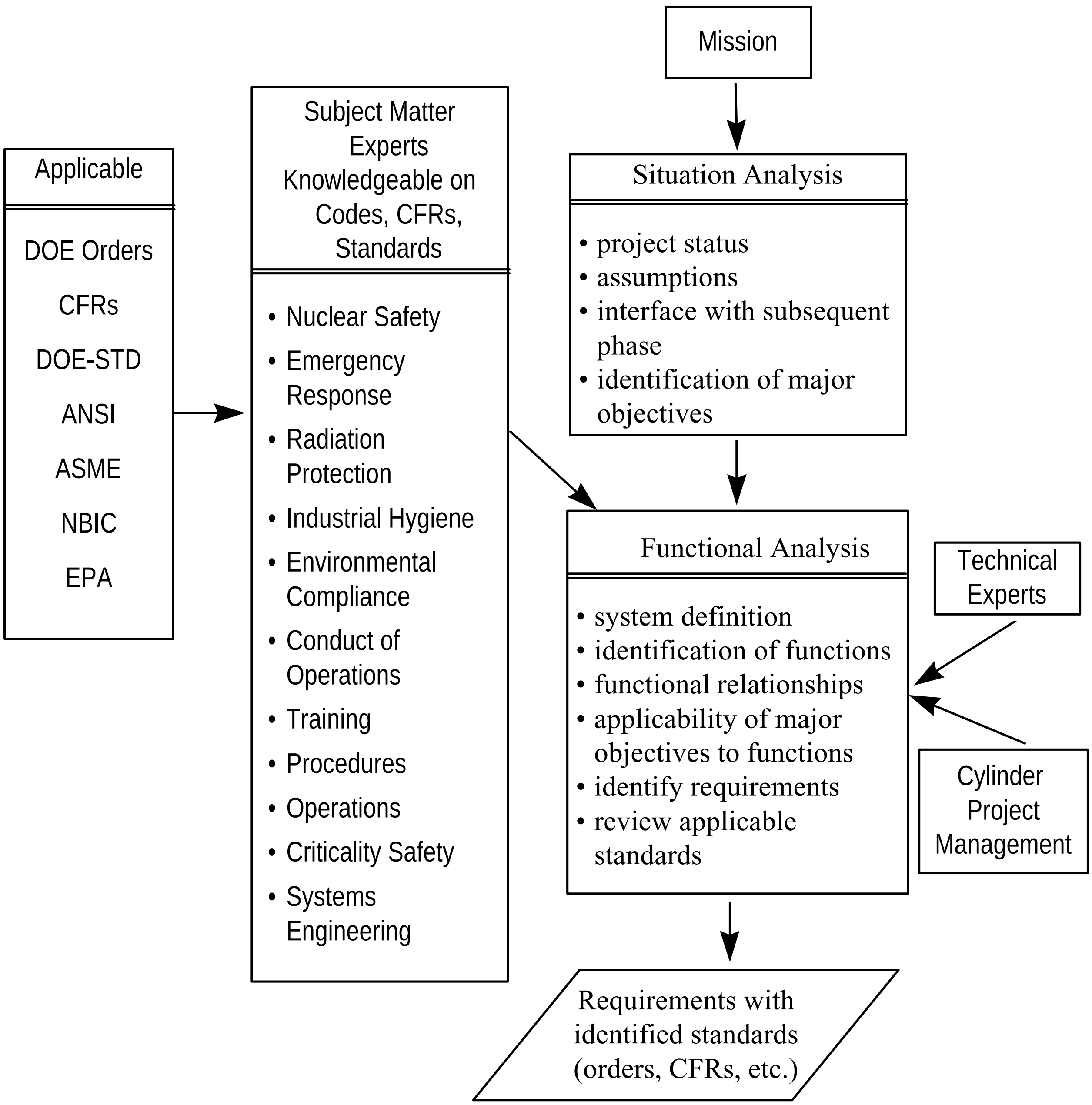


Fig. 4.1. Functional relationship of operations.

The system encompasses facilities, hardware, support systems, and/or subsystems for each of these operational functions. The flow of the operational functions is illustrated in Fig. 4.2. In addition to the operational functions, the system requires development and administrative support functions such as engineering development to realign and sustain the system effectiveness in meeting the Project mission.

The principal physical element of the system is the approximately 47,000 cylinders containing DUF_6. The cylinder population is generally characterized as follows.

- About 86% are 14-ton cylinders, 9% are 10-ton, 4% are 2½-ton, and 1% are miscellaneous capacities.
- The 10- and 14-ton cylinders are nominally 48 inches in diameter and range from 10 to 12 feet in length.
- The 2½-ton cylinders are 30 inches in diameter, about 7 feet in length, have skirts, and have walls that are either ½ or 13/32 inches thick.
- About 94% of the 10- and 14-ton cylinders are thin walled (5/16-inch wall thickness), and the rest of these cylinders are thick walled (5/8-inch wall thickness).
- About 20% of the 10- and 14-ton cylinders have skirted ends, and the rest are without skirts.
- Cylinders were procured on an "as needed" basis during five decades; consequently, vendors, designs and materials vary.
- Distribution of the cylinders is as follows: 61% are stored at PGDP, 29% at PORTS, and 10% at ETTP.
- The cylinders contain DUF_6 with a ^{235}U assay of less than 0.7%, enriched UF_6 less than 5.0% ^{235}U, and normal assay (nominally 0.71% ^{235}U) UF_6 .

Cylinder designs have evolved over the years. Design modifications vary from lifting lug shapes and stiffening ring designs to a change in the reference grade of steel. The cylinder model types and the number of each type that have been in service are shown in Fig. 4.3.

Manufacturing standards have also changed over the years. Current manufacturing guidelines are contained in ANSI 14.1 and are primarily directed at the original cylinder duty cycle.

Storage yards are another physical element of the system and are constructed of either concrete or compacted gravel. Cylinders are typically double stacked on yards in rows, and there is a small aisle between some rows. Some of these aisles are currently wide enough to allow personnel access, but most are not wide enough to allow passage of mobile equipment. In most cases, the cylinder heads face the aisles, to facilitate inspection and inventory control. The bottom cylinders are positioned primarily on concrete saddles, and a limited number of wooden saddles are currently in use. The top cylinders are positioned on two bottom row cylinders. Empty cylinders or heel cylinders may be triple stacked in rows with a small aisle between each row. Currently there are two yards at PORTS, eleven at PGDP, and five at ETTP. These yards cover a combined surface

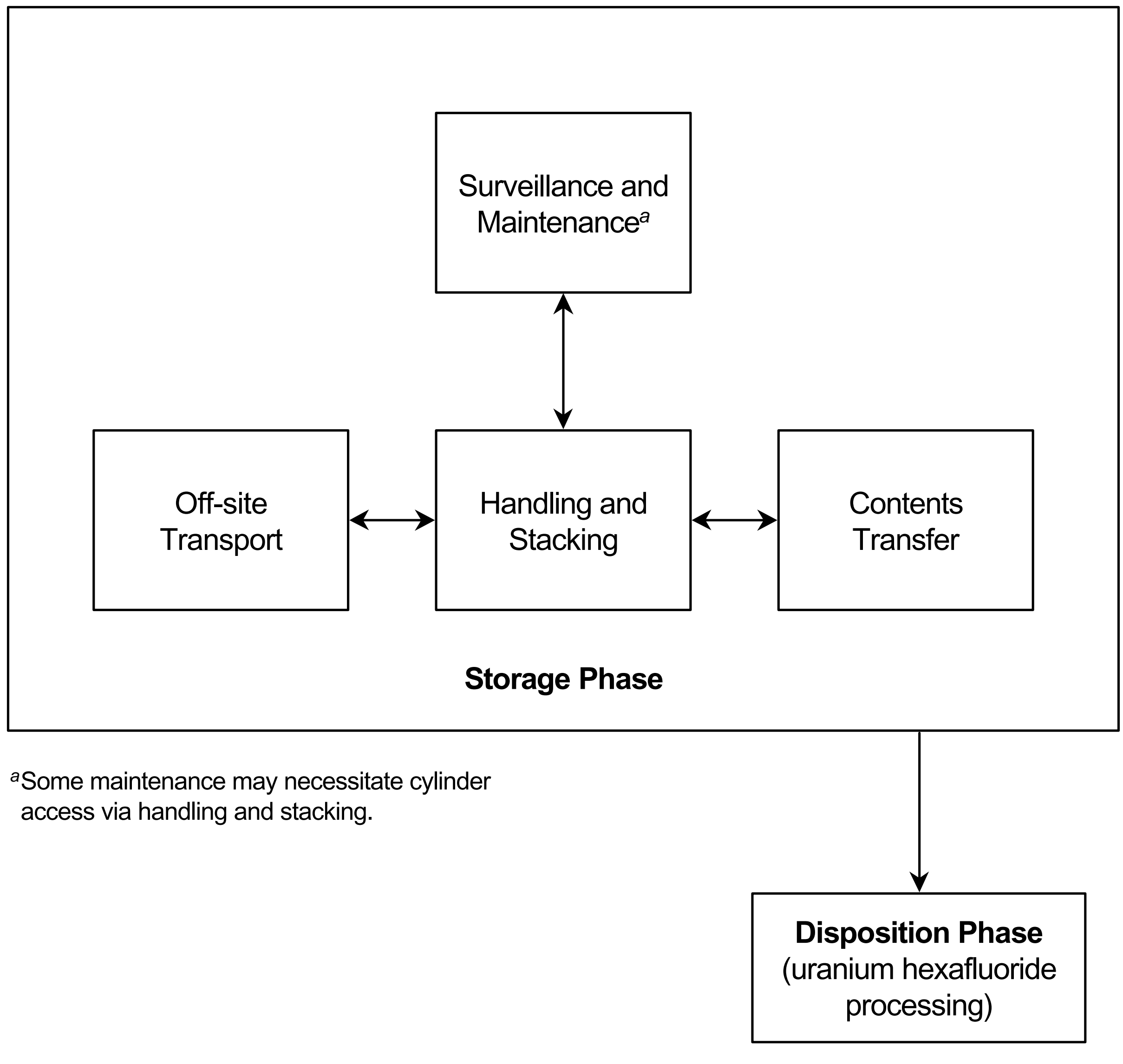
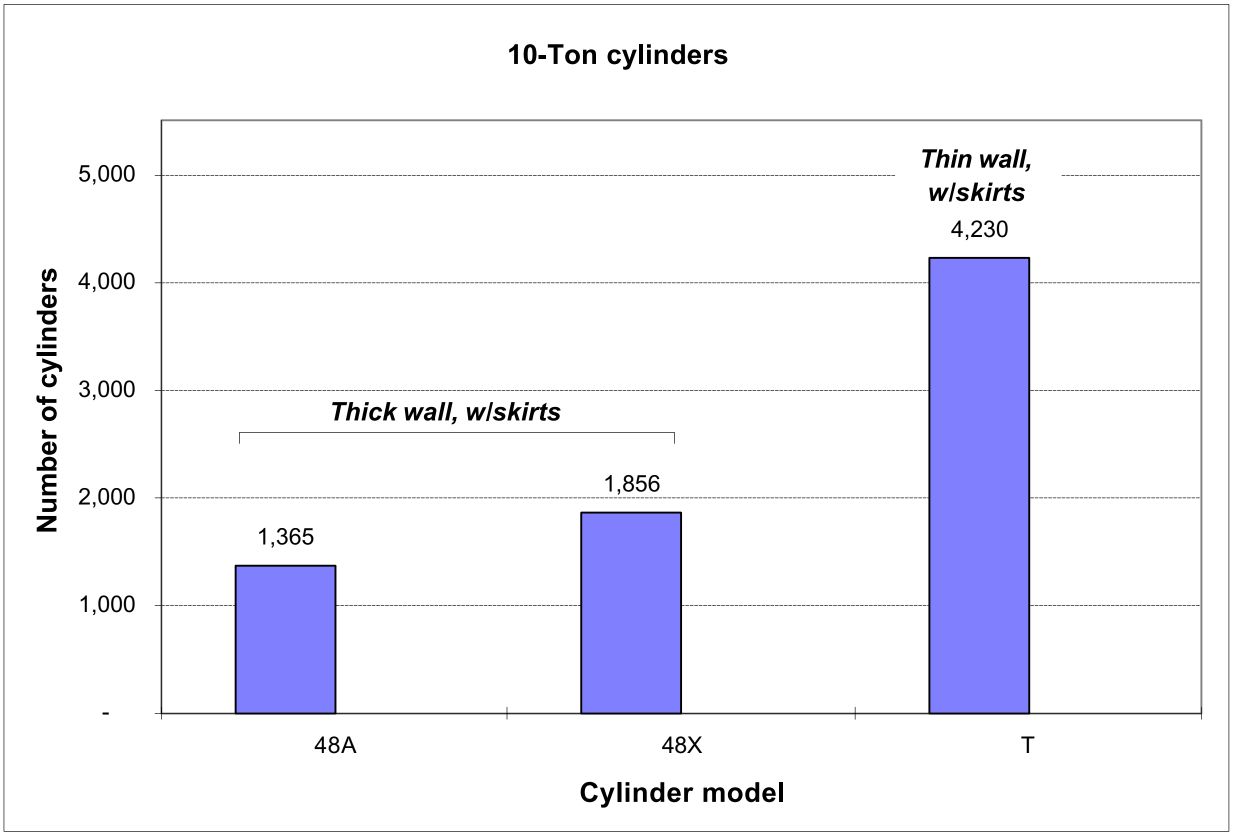


Fig. 4.2. Functional relationship of operations.



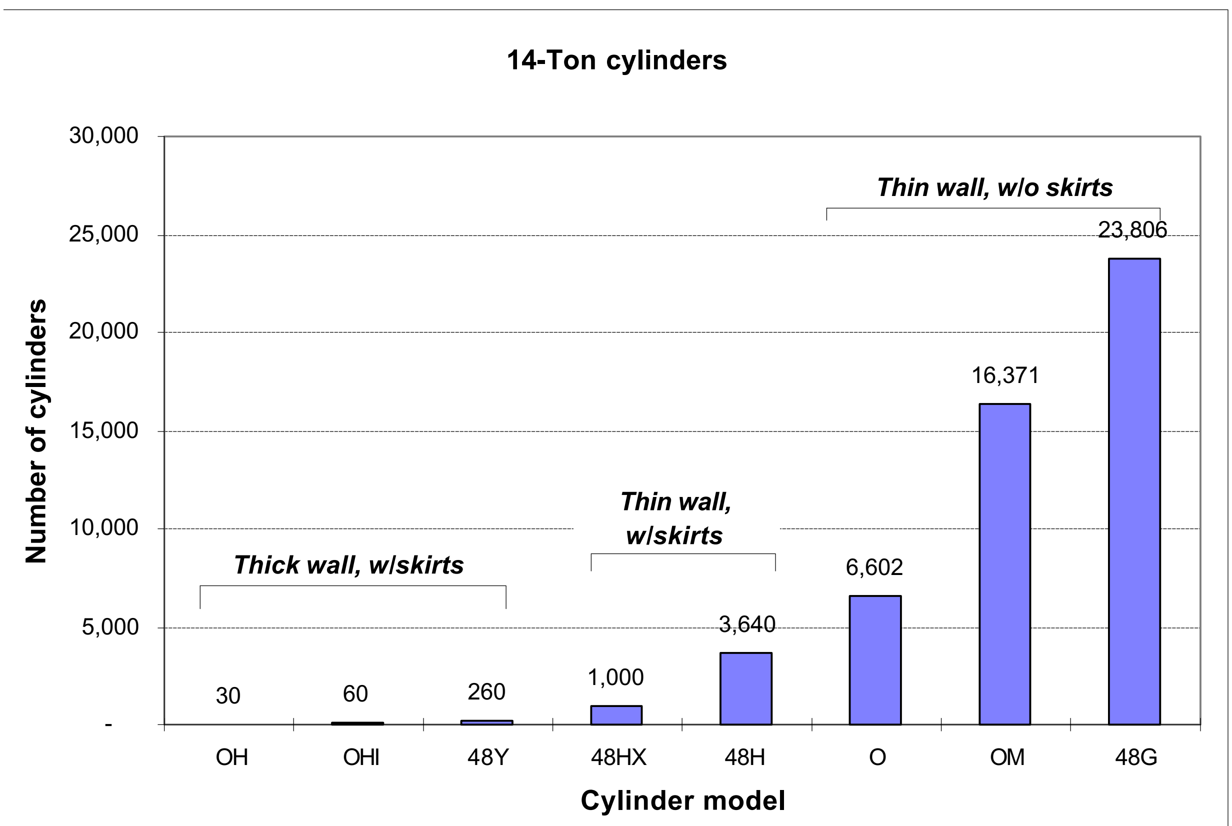


Fig. 4.3. Number of cylinders containing DUF_6 by model.

area of about 3.7 million square feet. The addition and reconstruction of storage yards is underway. The designation of current yards for each is as follows:

ETTP: K-1066-B, E, J, K, L
PORTS: X-745-C, E
PGDP: C-745-C, D, F, G, K, L, M, N, P, S, T

An additional physical element of the system is the cylinder handling equipment, which has also evolved over the years. Originally mobile cranes and removable bands were used to stack and unstack cylinders. Current handling equipment includes the cylinder stacker, which is used for stacking and unstacking as well as for transporting cylinders short distances. The “straddle carrier” is used for in-plant transport of cylinders. An additional device used for in-plant transport of cylinders is a specially designed trailer. Although there are slight variations in types of equipment items at the three sites, these are the principal pieces of hardware used to handle UF_6 cylinders.

Further elaboration of the system description is provided in documents that support the SRD such as SARs and technical specification documents.

4.2.1 System Functions

As shown in Fig. 4.2, the storage phase of the project comprises four operational functions. These functions are defined as follows:

Function 1: Surveillance and Maintenance—This function includes system activities to maintain cylinder and storage yard conditions.
Function 2: Handling and Stacking—This function focuses on the on-site movement of cylinders and associated support activities.
Function 3: Contents Transfer—This function addresses activities necessary to remove the cylinder contents. The emphasis for this function during the storage phase is replacement of cylinders unacceptable for long-term storage.
Function 4: Off-Site Transport—This function includes the activities necessary to ship cylinders among the DOE facilities or to other locations. The emphasis for this function during the storage phase is transport of cylinders to existing contents transfer facilities and optional inventory consolidation.

Functions 1 and 2 will include significant activity for the next 5 to 10 years as substandard conditions are mitigated (e.g. cylinder storage yard reconstruction and cylinder coating maintenance). After this corrective actions period, these two functions are expected to establish a steady state level of effort, including maintenance of cylinder coating. Functions 3 and 4 are expected to involve a minimal number of cylinders, but these functions are necessary to support the Project mission of safe storage and to facilitate the development of the dispositioning phase of the Project. The near-term level of activity within these two functions is dependent on the population of cylinders found to be unacceptable and repairable for continued storage. Another impact on the level of activity in Function 4 is the possibility of inventory consolidation from three sites to two or one. Inventory consolidation remains an option to effectively manage the inventory.

Administrative functions of the system also consist of components and activities. These administrative components support the operational activities needed to execute a viable system. The components include physical equipment (computers, informational databases, office space, etc.), personnel (Project managers, support personnel, engineers, finance officers, etc.), and documents (business plan, performance metrics, contracts, etc.). Activities are comprised of subsystems or processes such as training and procedural development, configuration control, verification, and work authorization. Section 4.2.2 provides a detailed listing of components in each operational function. Section 4.2.3 provides a detailed listing of activities within each operational function.

Training and qualification standards for personnel within the system are provided in Appendix C.

4.2.2 System Components

The system components are categorized as physical equipment, personnel, support organizations, documentation, and organization interfaces and are shown in Lists 1 through 5. The physical equipment and personnel are further categorized by the system functions.

List 1. PHYSICAL EQUIPMENT

Surveillance and Maintenance Function

Blast media

Coating (including paint, thinner, and cleaners)

Communication equipment e.g., radios

Cylinders (including nameplates, stiffening, rings, lifting lugs, skirts and seam welds)

Cylinder coating facility or designated area and associated equipment

Cylinder stand/turning fixture

Cylinder surface preparation equipment

Cylinder valves and plugs

Decontamination equipment

Emergency patch equipment

Information databases (including inspection database)

Inspection, monitoring, and survey equipment

Maintenance equipment for cylinders and storage facilities

Personal protection equipment

Storage facilities (including concrete and gravel yards, saddles, chocks, yard lighting, alarms, run-off, catch basins, and fallouts)

Technical assessment equipment, i.e., ultrasonic thickness (UT) apparatus

UF_6 (including depleted, enriched, and normal)

Valve change out equipment

Wastes from coating operations

Yard boundary control signage

Handling and Stacking Function

(in addition to some equipment listed for the surveillance and maintenance function)

Communication equipment (e.g., radios)

Check weight cylinders

Crane (including associated hoisting & rigging (H&R) equipment)

Emergency patch equipment

Empty cylinder handler

Equipment certification devices (load cells, etc.)

Forklift (including cylinder handling attachments)

Full cylinder handler/stacker

Maintenance equipment

Straddle buggy

Trailers and tractors (including trailer saddles)

Contents Transfer Function

(in addition to some equipment listed for the handling and stacking function)

Cylinder decontamination facility and associated equipment

Decontamination wastes

Weighting equipment

Feed and withdrawal equipment (including associated safety systems)

Heat/pressure differential source

Maintenance Equipment

New cylinders; new valves, and plugs

Pigtails

Test and inspection equipment

Off-Site Transport Function

(in addition to some equipment listed for the handling and stacking function)

HP survey equipment

Overpacks

Rail cars

Trailers and Tractors

TIDs (tamper indicating devices)

Tie-down rigging

Valve covers

List 2. PERSONNEL

Surveillance and Maintenance Function

Chemical operators

Cylinder inspectors

Computer support personnel

Construction contractors

Decontamination operators

Emergency preparedness/response team

Environ. monitoring technicians

Engineering support personnel

Equipment testing/inspection personnel

Health physics technicians

Health and safety representatives

Industrial hygiene technicians

Lab technicians

Line management/supervisor

Maintenance personnel

Material handlers

Metallurgists

NMC&A personnel

Nondestructive equipment personnel

Painters

Procedure writer

Qualified NBIC inspectors

Quality assurance and evaluation personnel

Records management personnel

Security officers

System safety engineers

Training personnel

Handling and Stacking Function

(in addition to some personnel listed for the surveillance and maintenance function)

Cylinder inspector

Equipment operator

H&R crew

H&R representative

Maintenance personnel

Operator to set saddles

Spotter

Contents Transfer Function
(in addition to some personnel listed for the handling and stacking function)

Maintenance personnel	Operator	Equipment test and inspection personnel

Off-Site Transport Function
(in addition to some personnel listed for the handling and stacking function)

DOE certified transportation "officer"	Health physics technician	Transport driver
H&R crew	Qualified inspector	Transportation safety representative

List 3. SUPPORT ORGANIZATIONS

Analytical Services	Equipment Test and Inspection	Program Management
Business Management (Finance, etc.)	Facility Safety	Quality Assurance
Chemical Operations	Health Physics (HP)	Records Management
Compliance	Industrial Hygiene (IH)	Security
Computer Support	Maintenance	Self Assessment
Emergency Preparedness	NMC&A	Technical Services
Engineering	Nuclear Criticality Safety	Transportation safety
Environ. Monitoring	Operations	Uranium Material Handlers
	Procurement	Utilities
		Waste Management

List 4. DOCUMENTATION

95-1 Implementation Plan	Job performance analyses	Shipping manifests and other DOT paperwork
Bid specifications	Maintenance Records	Sys. Engr. Mgmt Plan
Contracts	Management plans	System Requirement Doc.
Design Drawings (yards, saddles, fixtures, cylinders, etc.)	Materials & Transfer Records	Technical logs
DOT exemptions	Procedures	Technical reports
Engr. Development Plan	Project Mgmt. Plan	Technical Report to 95-1
Environmental Mgmt. Records	Recommendation 95-1	Technical specifications
HP/IH survey reports	Safety basis documentation (risk analyses, hazard assessments, etc.)	Training modules
Inspection reports	Self-assessment reports	Work Plans

List 5. ORGANIZATION INTERFACES

DOE
External standards bodies
Local, state, other federal agencies

Lockheed Martin Energy Systems
Lockheed Martin Utility Services
Lockheed Martin Energy Research Corporation

Other contracted organizations
Related industry companies
Site Management

4.2.3 System Activities

The activities specific to the Project are shown in List 6. The activities are organized by function.

List 6. SYSTEM ACTIVITIES

Surveillance and Maintenance Function

Alarm maintenance
Boundary/access control/posting/maintenance
Coating touch-up
Containment integrity monitoring
Cylinder coating maintenance
Cylinder coating/surface preparation, etc.
Cylinder patching/repair operations
Data entry
Decontamination
Design (yard, saddles, etc.)
Environmental monitoring
Financial accounting
ID plate replacement
Inspections (routine, coating quality evaluation)
Inventory accounting
Inventory modeling
Maintain emergency readiness/response/drills
Monitoring equipment maintenance/certification
Occurrence reporting
Project planning
Radiation/criticality and other hazard surveys
Records management (UCLIM, NMC&A, procedures)
Safety analyses
Security monitoring
Self assessments/audits
Skirt cleaning/coating/drain hole drilling
Technical studies/monitoring/analysis
Thickness data acquisition
Valve replacement and/or decon
Valve/plug replacement
Waste disposal
Worker training
Yard construction/reconstruction
Yard maintenance (sweeping, lighting, mowing)

Handling and Stacking Function

Cylinder inspection
Cylinder lifting, hauling, and stacking
Emergency response/readiness
Equipment maintenance
H&R training
HP survey
NMC&A verification and authorization
Old saddle disposition
Operator training
Saddle placement/moving
Thickness data acquisition

Contents Transfer Function

Authorization to transfer
Cylinder connections, heating
Cylinder inspection
Cylinder lifting and placement with building crane
Cylinder weighing
Feed and withdrawal preparation
HP monitoring
Investigation activities
Material control verification
Receiving cylinder preparation and connections
Safety systems testing monitoring
Thickness data acquisition as necessary
Transfer operation

Off-Site Transport Function

Cylinder pressure check
Cylinder shipment
Cylinder weight verification for fill limit check
DOT inspection of transport vehicle
DOT training
External inspection cylinder, cylinder components, and transport equipment
H&R to transport vehicle
HP survey
Installation of TIDs and valve covers
NMC&A verification/authorization
Securing cylinder on transportation vehicle
Stenciling of "radioactive LSA" on cylinder body
Thickness data acquisition as necessary
Transport authorization/documentation

4.3 FUNCTIONAL RELATIONSHIPS

The relationships between the functions is a key aspect to having a project of safe storage. Examples include: (1) cylinders must be handled and restacked to mitigate substandard storage conditions and reduce surveillance and maintenance risks and (2) it will be necessary to transfer the contents of cylinders found to be non-compliant with functional acceptance criteria and unrefurbishable to acceptable standards, also reducing surveillance and maintenance risks. Transfer of cylinder contents may involve off-site transport. Off-site transport may also be required to pilot or demonstrate the disposition of the DUF_6. Intra-site inventory consolidation, if found to optimize the system, would necessitate off-site transport of a large number of cylinders.

The primary interrelationship of these functions is the cylinder and an integrated set of acceptance criteria for cylinder condition that accommodates all functions. There are expected to be different criteria for each of the four system functions: surveillance and maintenance, handling and stacking, contents transfer, and off-site transport. Existing standards such as ANSI N14.1 and USEC-651[13] provide detailed criteria for specific functions, respectively off-site transport and liquefaction transfer of contents. ASME Boiler and Pressure Vessel Code[1] provides design and construction standards for cylinders. A portion of the cylinder population does not meet the 1/4 inch minimum wall thickness for thin wall cylinders specified in these standards. The relationship between functional criteria will be addressed in the development of an integrated set of cylinder acceptance criteria. See Sect. 5.4 for the rationale to develop these criteria. These criteria will enable the Project to successfully meet its mission for the storage phase, will optimize the use of existing containers with respect to the overall system life cycle, and will optimize ultimate disposition flexibility.

Compliance with these acceptance criteria will necessitate continued maintenance and verification. Cylinders that do not currently meet the acceptance criteria, require other operational functions to initiate precautionary measures, including additional inspections and possible operations. Examples of this scenario include:

- The mass limit on cylinder contents is not a limiting criterion for the surveillance and maintenance function and is not verified within this function; however, safety precautions within the transfer function require that the mass content be verified, because some cylinders are above weight limits for routine heating. Heating overfilled cylinders could result in hydrostatic rupture.
- An internal vacuum is not a limiting criterion for the cylinder handling and stacking function and is not verified within that function. However, off-site transport standards require that the cylinder contents be at or below atmospheric pressure. These criteria are verified within the transport function, and it may be necessary to reduce internal pressure before shipment.

The Project will establish maintenance and verification activities within each function to compensate for cylinders that do not meet the functional acceptance criteria. These activities will ensure the risks of processing cylinders from one function to another are sufficiently controlled.

The capacity of a function is determined by the rate at which it can perform its intended actions. This rate is also interrelated to other functions. Examples include:

- The capacity to handle, restack, and paint cylinders currently in substandard storage conditions could impact the number of cylinders that meet acceptance vessel criteria in out-years and thus the number of cylinders requiring mitigative actions.
- The capacity to transfer the contents of unacceptable cylinders impacts the duration for which these cylinders have to remain in the surveillance and maintenance function. Risks with prolonged storage of unacceptable cylinders need to be balanced with the capacity to replace or repair these cylinders.

The Project will ensure function capacity is made available commensurate with the impact on other functions. Other functional relationships include nuclear materials accountability control, contamination control, information from technical studies, and cylinder history records management. These relationships will be identified and appropriate controls verified and/or implemented to maintain continuity of the system. [*Derived*]

4.4 FUNCTIONS CROSSWALK WITH MAJOR OBJECTIVES

Figure 4.4 provides an overview of the major objectives' applicability to the system functions. All major objectives are applicable to the entire system; however, this overview identifies the emphasis areas for each major objective. The overview provides the basis for the functional analysis used to determine Project requirements.

Major objective	Operational Function			
	surveillance and maintenance	handling and stacking	contents transfer	off-site transport
MO 1: Achieve and maintain acceptable risk	<-------unilateral application------->			
MO 2: Achieve and maintain cylinder integrity	<emphasis area>			
MO 3: Improve conduct of operations	<-------unilateral application------->			
MO 4: Evaluate and monitor containment integrity	<emphasis area>			
MO 5: Administer the system	<-------unilateral application------->			

Fig. 4.4. Applicability of major objectives to system functions.

As shown in Fig. 4.4, the major objective *Achieve and Maintain Acceptable Risk* applies unilaterally across all system functions. A graded approach, depending on the potential consequences and frequency, is used to evaluate specific risks within each function. The significant limiting hazard and accident analysis cases include the release of solid and gaseous UF_6 to the atmosphere during handling and a cylinder yard fire.[14] For potential operations involving contents transfer operations via liquefaction the boundary accident analysis is the drop of a liquid-filled cylinder.[10, 11]

Activities to support the major objective *Achieve and Maintain Cylinder Integrity* are not unilaterally applied to all system functions. The greatest level of effort to mitigate deterioration is concentrated in the storage, and handling functions where cylinder operations are continuous. The primary actions associated with successfully meeting this objective include facility improvements, coating maintenance, and valve and plug maintenance. These actions do provide benefit to the transport and transfer functions by reducing risk and increasing Project flexibility.

The *Improve Conduct of Operations* major objective is similar to the first objective, *Achieve and Maintain Acceptable Risks*, and unilaterally applies to all system functions. Improving the conduct of operations from current conditions in all functions is accomplished through structured work control and training processes. The effectiveness of these administrative controls is a key element to successfully meeting the Project mission.

Activities necessary to meet the major objective, *Evaluate and Monitor Containment Integrity* lie primarily in the surveillance and maintenance function of the system. However, the criteria for which these actions verify acceptable conditions consider all criteria within the system.

The fifth major objective, *Administer the System* incorporates the support activities to maintain the operational functions. These support activities including obtaining financial, capital, and intellectual resources, integrating and optimizing these deployment of these resources among all operational functions. System responsiveness to external forces such as changes in regulations, and UF_6 dispositioning constraints is a part of this objective.

5. REQUIREMENTS TO ACHIEVE MAJOR OBJECTIVES

Requirements for the UF_6 Cylinder Project are expressed as ***system requirements*** and more detailed ***technical requirements***. The system requirements represent a comprehensive list of essential characteristics necessary to successfully meet the Project mission and major objectives. Technical requirements are subordinate to system requirements and provide the specificity necessary for safe operation of the system.

The system requirements within this document provide the framework for developing activities necessary to accomplish its mission. The Systems Engineering approach is being applied concurrently with an ongoing Project, and many actions are in progress. The SEMP establishes the technical basis for system activities through an analysis of requirements contained herein and others as they are identified.

The requirements in the following section were developed through a functional analysis of the activities and components identified in Sect. 4. These activities were analyzed in the context of each major objective to determine what requirements needed to be established to accomplish the objective. To bound the development of requirements, the functional analysis considered only those standards that directly affect this Project and its ability to meet its mission.

Categories of requirements under each major objective have been established in the process of linking major objectives to requirements and functions. These categories are shown in Fig. 5.1. These categories are not requirements of the Project. They summarize the rationale for the requirements.

Requirements were reviewed to identify applicable standards and governing documents. Key standards are identified in brackets [] after each requirement. A comprehensive allocation of standards to requirement categories is provided in Appendix B. Section 2 provides a listing of standards and governing documents for the Project and describes the standards identification process. The extent of compliance with these standards is limited to the scope of the requirement. If a requirement does not have an applicable standard or governing document, the standard is considered to be derived within the Project.

The following sections relate system requirements to the major objectives described in preceding sections of this document. The motivation for the development of these requirements within major objectives is to respond to the need expressed by the objective and, ultimately, to determine activities necessary to accomplish the objectives. Where necessary, technical requirements have been provided to support the specificity needed to accomplish the intent of the system requirement, major objective, and Project mission. The technical requirements are identified by unique alphanumeric characters after the system requirement number.

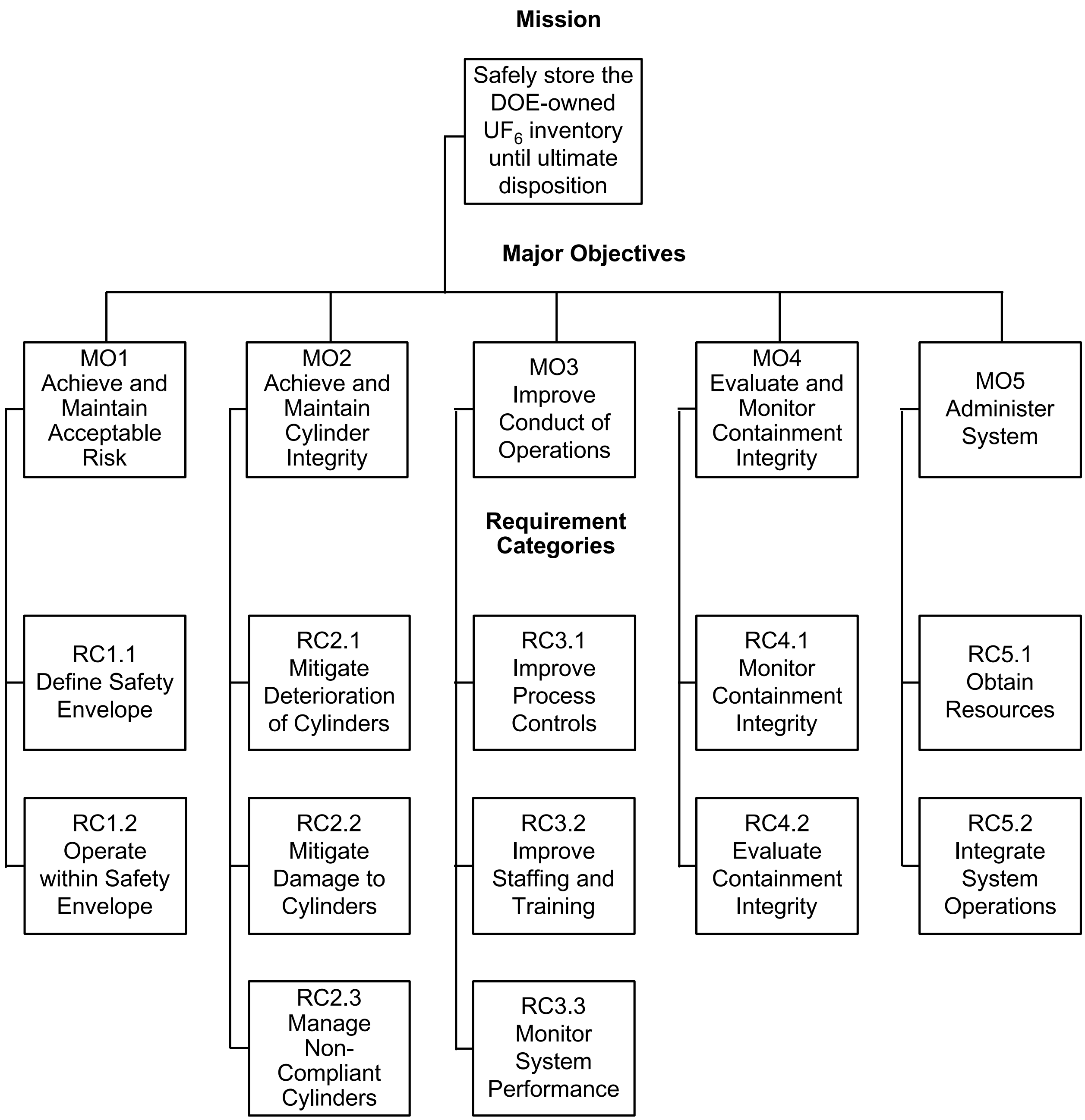


Fig. 5.1. System requirement structure.

5.1 REQUIREMENTS TO ACHIEVE AND MAINTAIN ACCEPTABLE RISK

5.1.1 Define the Safety Envelope

Major Objective (MO) 1, Requirement Category 1: Define the safety envelope for the storage of UF_6 and consider it in all system requirements, procedures, and Project elements, that will take into consideration DOE orders and pertinent laws, including state and federal.

Description and Rationale

In order to ensure a safe storage system, the system has to first be defined in terms of the form, fit and function of components and activities needed to operate. This definition provides a system description that is used to analyze the system for hazards and potential consequences and to integrate the functional flow of activities. The UF_6 Cylinder Project comprises a system currently in operation developed over decades of UF_6 processing. There is limited documentation on the technical basis of components within the system. The intent of first system requirement and subordinate technical requirements is to verify the existence of vital technical basis information for this system and to institute configuration control to maintain this basis for operation throughout the storage phase of the system. An example of vital information is the identification of standards to which specific cylinder populations were designed, manufactured and certified. This information is necessary to plan operations in the disposition phase of the project. The degree to which the system description will be documented is dependent on the hazards and consequences identified for analysis beyond what the current description is capable of providing. An additional reason for developing a more rigorous system description is when integration of the system is found lacking to the degree that the mission and objectives of the Project are in jeopardy of being met.

The remaining system and technical requirements within this requirement category focus on identifying, documenting, and maintaining current the hazards, risks, and controls to achieve and maintain acceptable risks. The minimal controls necessary to manage the risks within planned activities must be determined, to successfully maintain a safe Project. Actions to identify and evaluate hazards and determine minimal controls define the safety basis for the system. This safety basis is the bounds for safe operation of the necessary system activities and instills a certain safety envelope. The ongoing activities and potential new activities within the system are then managed within the bounds defined by the safety basis. This requirement category defines and documents the hazards and their associated risks and consequences for clear dissemination to the work force and control within the safety basis.

An integral function of the safety basis is to grade the hazards. This hazard grading facilitates clear delineation of which hazards pose the greatest risk and where multiple controls (defense in depth) are necessary and most beneficial. The grading also establishes the basis for prioritizing risk reduction actions.

Requirements and Intent

The following requirements ensure the safety aspects of the system are defined, documented, and maintained.

1.1.1 The Project technical configuration shall be defined and documented.

1.1.1a The functional relationships shall be identified to establish continuity of the system. [10 CFR 830.120]

1.1.1b Storage history for each cylinder shall be documented and maintained for the service life of the cylinder. [10 CFR 835, DOE 5633.3B]

1.1.1c Functional relationships shall be documented. [10 CFR 830.120]

1.1.2 Project hazards shall be identified and documented.

1.1.2a The system hazards shall be identified, evaluated, and documented as part of a complete safety analysis to define the safety envelope. [DOE 5480.7A, DOE 5480.23, DOE 5480.22, ANSI 8.1, 8.3, 8.7, 8.20, DOE 6430.1A]

1.1.2b The hazards documented in the safety basis shall be periodically reviewed and updated to reflect a current definition of hazards within the system. [DOE 5480.21, DOE 5480.23, DOE 6430.1A]

1.1.3 The Project risk(s) and required controls shall be documented.

1.1.3a Maintenance and verification activities within each operational function shall be documented. These activities are to compensate for cylinders in the system that do not meet all functional acceptance criteria. These activities ensure the risks of processing cylinders from one function to another are sufficiently controlled. [Derived]

1.1.3b The system risks and minimum controls shall be identified, evaluated, and documented as part of a complete safety analysis to define the safety envelope. [DOE 5480.7A, DOE 5480.22, DOE 5480.23, ANSI 8.1, 8.3, 8.7, 8.20, DOE 6430.1A]

1.1.3c The safety basis shall be periodically reviewed and updated, to reflect a current safety analysis and risks within the system. [DOE 5480.23, DOE 6430.1A]

1.1.3d Appropriate evaluations of compliance with the safety envelope shall be conducted when the safety basis is in question due to changes in procedures, work scope, and/or storage configurations. [DOE 5480.21]

1.1.3e Appropriate reviews and assessments shall be performed to ensure the preparedness of new activities and facilities, and the restart of activities as appropriate. [DOE 5480.31]

1.1.3f The concept of as low as reasonably achievable (ALARA) shall be incorporated in the risk management and reduction efforts within the Project. [10 CFR 835, 29 CFR 1910, 29 CFR 1926, DOE 6430.1A]

5.1.2 Operate within the Safety Envelope

MO 1, Requirement Category 2: Operate within the safety envelope by instituting safety-related controls and monitoring for safety within the system.

Description and Rationale

Facilities and operations must be monitored to determine the presence of hazards and potential initiators. These hazards and initiators are identified in the safety analysis. This monitoring ensures compliance with the safety envelope and identifies where necessary mitigative actions to maintain compliance with the safety envelope are needed. These mitigative or corrective actions are prioritized to optimize the reduction of risks within the Project.

Necessary controls to maintain acceptable risk within the system are identified through a safety analysis. These controls are invoked through Safety Management Programs at the respective storage sites by contracted personnel. These Safety Management Programs include such aspects as radiation protection, industrial hygiene, and emergency response.

Additional controls are instituted as a result of the uranium in storage being considered a "source material" as defined by the Atomic Energy Act. This designation requires accountability and security of the inventory. In order to stay within the safety envelope, mass and assay must be maintained. Movement, including off-site transport of cylinders containing accountable inventory, is controlled through an NMC&A program. Security within the facilities is maintained with appropriate perimeter fencing, routine patrols, and storage yard lighting.

Requirements and Intent

The following requirements are established to ensure facilities and operations are monitored for compliance with the safety envelope.

1.2.1 Required risk controls shall be implemented.

- 1.2.1a An industrial hygiene program shall identify and administer controls to ensure proper management of industrial hazards. [10 CFR 830.120]
- 1.2.1b Accountability of the inventory shall be managed through a NMC&A program. This program provides the assay and mass quantities necessary for controlling fissile material relative to criticality concerns.
  [10 CFR 835, DOE 5633.3B]
- 1.2.1c Cylinders containing fissile material shall be segregated from non-fissile inventories and spaced in accordance with nuclear criticality control guidelines. [10 CFR 835, ANSI 8.1, 8.7, 8.19, DOE 5633.3B]
- 1.2.1d The security of the UF_6 inventory shall be maintained in accordance with a safeguards and security program. This program specifies and maintains the periodicity of routine patrols and physical boundaries. The program also specifies other security specifications including lighting, as determined necessary.
  [DOE 5633.3B]
- 1.2.1e Cylinder storage in ground contact shall be prevented. Temporary placement of cylinders on the ground during relocation and staging operations is acceptable, but should not exceed specified duration. [10 CFR 835]
- 1.2.1f Contracted organizations shall operate within an established safety envelope. [10 CFR 830.120, DOE 5480.22, DOE 5480.23]

1.2.1g Prioritization of deficiencies shall be used in the optimization of actions taken to reduce risks within the Project. [Derived]

1.2.2 Performance shall be monitored and evaluated to identify potential risks within the Project.

1.2.2a Facility safety walk-throughs shall be conducted regularly to identify initiators and determine ameliorative actions. [10 CFR 830.120, 10 CFR 835, USEC-651]

1.2.2b The Project shall establish system performance indicators in critical areas to determine the effectiveness of activities. [DOE 4700.1, 10 CFR 830.120]

5.2 REQUIREMENTS TO ACHIEVE AND MAINTAIN CYLINDER INTEGRITY

5.2.1 Mitigate Deterioration of Cylinders

MO 2, Requirement Category 1: Mitigate deterioration of cylinders focuses on the degradation of cylinders from exposure to storage facility conditions.

Description and Rationale

Currently, the UF_6 is stored outdoors, in mild steel containers that are fully exposed to atmospheric conditions. The atmospheric conditions at the present storage facilities maintain a corrosive environment for mild steel, with high relative humidity and an abundance of precipitation. This configuration necessitates the comprehensive management of mild steel exposure to wetness. Mild steel exposure to wetness has ramifications on the overall Project mission that warrant significant defense in depth. The primary control for minimizing cylinder time of wetness is proper drainage of the storage facilities (i.e., the load bearing surface) and from cylinder bodies. The second level of protection is adequate ventilation and separation from regions with continuous high humidity regions (i.e., proximity to the ground).

The third level of defense is a protective coating to be maintained on cylinder bodies. Maintaining a coating is a new requirement for the existing system. Coating aspects such as toughness and durability need to be integrated with components that physically interface with coating such as handling equipment and saddles. Establishing compliance with this requirement requires significant resources and time. To compensate for the duration of non-compliance with this requirement, cylinders will be prioritized for coating. This prioritization will include, among operational logistics, the present condition of cylinders and the projected corrosion rate(s).

Other potential initiators of loss containment involve the failure of valve and/or plug. Scenarios of valve/plug failure are specific to the function being imposed on the cylinder (surveillance and maintenance, handling and stacking, contents transfer, and off-site transport). However, generic scenarios involve the failure of the component and the release of UF_6 and reaction products as contamination or potential exposure for the worker and environment. An ingress of moisture to the ullage facilitates further degradation of the valve or plug. Substantial quantities of moisture in the cylinder can establish internal corrosion as a loss of a containment initiator. The interface of dissimilar metals (e.g., bronze alloy valve/plug connected to a mild steel container) can affect the integrity of the steel cylinder. The control of these initiators as determined by the Project will be managed through a valve management program.

Requirements and Intent

2.1.1 A barrier between the cylinder mild steel containment surfaces and wetness shall be maintained.

2.1.1a A cylinder maintenance coating program shall be instituted to maintain cylinder coatings throughout the storage phase of the system. [10 CFR 830.120, 10 CFR 835]

2.1.1b The coating application and maintenance shall be prioritized and scheduled based on the knowledge of the present condition of the cylinder, the forecasted deterioration of wall thickness, and operational logistics with yard refurbishment, cylinder access, and location/density of priority cylinders. [10 CFR 830.120, 10 CFR 835]

2.1.1c Toughness, durability, and repair qualities shall be criteria in the review and acceptance of coatings and replacement coatings. [DOE 6430.1A]

2.1.2 Water retention on cylinders caused by cylinder structural features shall be minimized.

2.1.2a Skirt region drainage shall be promoted, to minimize corrosion. [10 CFR 830.120, 10 CFR 835]

2.1.3 Water retention on cylinders caused by cylinder support structures shall be minimized.

2.1.3a Cylinder saddles shall provide ventilation between the cylinder and the load-bearing surface. [10 CFR 830.120, 10 CFR 835,]

2.1.3b Cylinder saddles shall facilitate proper drainage from the cylinder and storage facility. [10 CFR 830.120, 10 CFR 835,]

2.1.4 Water retention on and adjacent to storage facilities shall be minimized.

2.1.4a Storage facilities shall be designed for the expected life of the storage phase of this Project and for the expected operational activities. [10 CFR 830.120, 10 CFR 835, DOE 6430.1A]

2.1.4b Cylinders shall be stored on load-bearing surfaces that, when in use, drain properly (as determined by the Project) and rigidly support handling equipment during operations. [10 CFR 830.120, 10 CFR 835]

2.1.4c Cylinders and supporting saddles shall be configured on storage facilities to facilitate proper drainage. [10 CFR 830.120, 10 CFR 835]

2.1.5 Cylinder valve and plug integrity shall be maintained to project standards.

2.1.5a A valve and plug integrity management program shall be established to minimize potential hazards, through monitoring and corrective actions, associated with the presence and failure of these components. [10 CFR 830.120, 10 CFR 835, USEC-651]

2.1.5b Failed valves and plugs including intermittent leaking shall be detected and corrected. [10 CFR 830.120, 10 CFR 835, USEC-651]

2.1.5c Valves with missing or damaged parts shall be replaced or the parts replaced to meet functional criteria. [10 CFR 830.120, 10 CFR 835, USEC-651]

5.2.2 Mitigate Damage to Cylinders

MO 2, Requirement Category 2: Mitigate damage to cylinders from operations.

Description and Rationale

Physical damage to the cylinder from processing can affect the containment integrity in varying degrees. Specific types of damage can be unique concerns to various system functions. The loss of protective coating is a concern to the surveillance and maintenance function, and gouges and dents can be a concern to the surveillance and maintenance function and the contents transfer function. The risk of this damage occurring lies primarily in the handling and stacking function of the Project. Much of the potential damage lies in the areas where saddles and handling equipment contact the cylinder. This anticipated contact is managed by the design of the saddles and equipment and by the design and maintenance of the coating. Other, undesirable contact is controlled by configuration design of the storage array and through administrative control in handling procedures. Administrative control is also used as mitigative measure to identify for corrective action any damage that does occur.

To compensate for the cylinders in the system that have already incurred physical damage from processing, maintenance and verification activities will be instituted when processing cylinders between operational functions that have different acceptance criteria. These verification actions will ensure no cylinder is accepted without recognizing constraints due to cylinder condition or condition of the contents. In addition to these maintenance and verification activities, methods for processing constrained cylinders (such as corroded cylinders and non-coded cylinders) will be established. Processing includes handling and stacking, off-site transport, contents transfer, and maintenance within the surveillance and maintenance function. Currently administrative controls are in place that authorize the movement and processing of cylinders between NMC&A accounts. This level of control is appropriate to satisfy technical requirement 2.2.1h.

Requirements and Intent

To minimize damage to cylinders during the handling and stacking function, the following requirements have been established.

2.2.1 Cylinder containment integrity shall be maintained during handling, processing, and transport operations.

2.2.1a A viable means to transport cylinders off-site that do not meet DOT standards shall be determined for foreseeable shipments. [49 CFR, 10 CFR 830.120]

2.2.1b Maintenance and verification activities shall be implemented within each operational function to compensate for cylinders in the system that do not meet the functional acceptance criteria. These activities ensure the risks of processing cylinders from one function to another are sufficiently controlled. [Derived]

2.2.1c Cylinder handling and stacking configurations that minimize potential impacts between cylinders shall be established. [10 CFR 830.120, USEC-651]

2.2.1d Engineering controls to reduce potential cylinder damage using existing equipment during stacking operations shall be evaluated. [29 CFR 1910]

2.2.1e The design of new handling equipment shall consider additional controls to prevent coating damage on the body of the cylinder and cylinder damage by operator error when lowering cylinders for placement. [USEC-651]

2.2.1f New saddle design shall include the protection of cylinder coating. [DOE 6430.1A]

2.2.1g Operational controls for handling cylinders shall incorporate additional precautionary measures for handling degraded cylinders. [DOE 5480.19]

2.2.1h An NMC&A program shall control, through authorization, the movement and processing of the UF_6 inventory. [10 CFR 835, DOE 5633.3B]

2.2.2 Cylinder handling, processing, and transporting equipment operators shall be proficient.

2.2.2a Operators shall be qualified to verify their proficiency in the use of such equipment. [10 CFR 830.120]

5.2.3 Manage Non-Compliant Cylinders

MO 2, Requirement Category 3: Replace or repair unacceptable cylinders.

Description and Rationale

It is expected that, because of past storage practices, some cylinders will not meet the all functional acceptance criteria that are under development. See Sect. 5.4 for a discussion of the criterion's development. Cylinders that don't meet these criteria will be replaced or repaired. However, these unacceptable cylinders are not expected to present an imminent danger to workers, the public, or the environment. The means for managing this population depends on the extent and nature of defiency and the size of the population. Currently, failed cylinders are few and the means to remove them from service is obtained from contracted services. DOE does not possess the ready capacity to replace or repair unacceptable cylinders. Method and capacity for managing unacceptable cylinders will be established in conjunction with determining the unacceptable population and the nature and extent of their deficiency.

The primary criterion for permanent repair of cylinders is compliance with ASME Boiler and Pressure Vessel Code.[1] Based on discussions with private companies that have repaired boiler and pressure vessels, repairing corroded cylinders is a feasible alternative to cylinder replacement. As this permanent repair capacity is not currently available repairs such as welding of patches are considered temporary. Other repairs such as reattaching name plates will be done in accordance with NBIC standards where they can be met.

Requirements and Intent

2.3.1 Replacement cylinders, valves, and plugs shall be designed, manufactured, and procured in accordance with anticipated service life and configuration. [ANSI N14.1, DOE 6430.1A, USEC-651]

2.3.2 Personnel replacing/repairing cylinders shall be knowledgeable of deteriorated cylinder conditions. [10 CFR 830.120, DOE 5480.23]

2.3.2a Operators shall be trained on the risks and hazards of handling UF_6. [10 CFR 830.120, DOE 5480.23]

2.3.3 Non-compliant cylinders shall be repaired or replaced to meet Project standards. [USEC- 651]

2.3.3a The functional capacity to safely manage non-compliant cylinders shall be established in order to minimize the impact on the surveillance and maintenance function. [Derived]

2.3.3b Methods for processing non-compliant cylinders shall be established as necessary. [10 CFR 830.120, 10 CFR 835, DOE 5480.23]

5.3 REQUIREMENTS TO IMPROVE CONDUCT OF OPERATIONS

5.3.1 Improve Process Controls

MO 3, Requirement Category 1: Improve work process controls for accomplishing the intent of operational activities.

Description and Rationale

Process controls within this requirement category focus on work controls from developing work plans and command media to authorizing and monitoring work activities. Work controls are instituted in the system to ensure operational activities comply with standards and meet the intent of the planned operations.

Administrative procedures are the primary controls within the system. Procedures are necessary to perform activities within all operational functions (surveillance and maintenance, handling and stacking, contents transfer, and off-site transfer). The quality of these procedures reflects the Project's ability to control risks. Procedure development must consider the intent of the activity, the impact if not accomplished, the knowledge and skill of personnel performing the operation, and any site-specific requirements. The procedure development also considers the effectiveness of the training.

Maintaining this work control necessitates periodical review and update of procedures, work plans, and training modules to incorporate lessons learned, requirement changes, safety bases, and engineering development while maintaining three-site consistency. Monitoring of performance to ensure compliance with command media is an integral part of maintaining adequate work controls.

Requirements and Intent

3.1.1 The system configuration (physical components, functions, and documents) shall be controlled through a formal process.

3.1.1a A configuration management process shall be instituted to control configuration items. [10 CFR 830.120]

3.1.2 Work controls, activities, procedures, work plans, and permits shall be developed, authorized, and implemented through a structured process.

3.1.2a Procedures and work plans shall incorporate all the pertinent information (e.g., safety precautions, emergency response, lessons learned, and site specific requirements). [10 CFR 830.120, 10 CFR 835, DOE 5480.23, DOE 5633.3B]

3.1.2b Procedures shall be reviewed and updated, to ensure three-site consistency and elimination of any procedural contradictions to ensure sufficient and uniform risk management within the Project. [10 CFR 830.120, 10 CFR 835, DOE 5480.23, DOE 5633.3B]

3.1.2c Any site-specific documentation requirements shall be identified and taken into consideration in the procedure process. [10 CFR 830.120, 10 CFR 835, DOE 5480.23, DOE 5633.3B]

3.1.2d Performance shall be periodically monitored and assessed to determine procedures are being followed. [10 CFR 830.120]

5.3.2 Improve Staffing and Training

MO 3, Requirement Category 2: Improve staffing and training to ensure operational activities are conducted in a safe manner.

Description and Rationale

In addition to quality procedures the Project needs current and effective training to procedures to successfully control initiators and to accomplish the intent of operations. Performing personnel will have the capacity to understand the intent of the operation and the safety aspects and will be able to demonstrate through performance the proper use of procedures. Safety aspects of the operation flow down from the safety basis. Performing personnel are to be generally knowledgeable of the Project's safety basis.

To accomplish this category of requirements, a structured personnel selection and training is instituted. This process includes the training organization interfacing with the procedure development process to ensure training modules are current and effective. Personnel knowledgeable of specific procedures intent will periodically review training and the training modules, to ensure the intent is being presented accurately.

To maintain an effective training process, work performance will be monitored. This monitoring will provide the necessary information to verify the retraining frequency and the adequacy of the training course work.

Requirements and Intent

3.2.1 Personnel shall be selected, trained, and developed through a structured process.

- 3.2.1a Personnel shall be trained to provide understanding of the safety documentation. [10 CFR 830.120, 10 CFR 835, 29 CFR 1910, DOE 5480.23, DOE 5633.3B]
- 3.2.1b Personnel shall be trained and retrained at frequencies determined by the training organization considering the potential consequences of the task, the complexity of the task, and the frequency with which it is performed. [10 CFR 830.120, 10 CFR 835, 29 CFR 1910.120, DOE 5480.23]
- 3.2.1c A database shall be utilized to cross-link training requirements (including training to procedures and training intervals) to training records. The data base shall be used to maintain training records current with procedure revisions. [10 CFR 830.120, 10 CFR 835, DOE 5480.23]
- 3.2.1d A performance-based methodology shall be used for training. [10 CFR 830.120, DOE 5480.23]
- 3.2.1e Training modules shall incorporate all pertinent information (e.g., safety precautions, hazards, emergency response, lessons learned, and site specific requirements. [10 CFR 830.120, 10 CFR 835, DOE 5480.23, DOE 5633.3B]
- 3.2.1f Performance shall be periodically monitored and assessed to determine the effectiveness of training. [10 CFR 830.120]

5.3.3 Monitor System Performance

MO 3, Requirement Category 3: The performance of activities supporting the Project will be periodically monitored and assessed to ensure the expected performance of the activities are being met.

Description and Rationale

The success of the Project is supported by quality procedures and training to prepare performing personnel. To accomplish objectives, the actions taken by performing personnel have to complete the desired tasks, be performed in a safe manner, and achieve the intent of operation. Experience has shown actual performance can vary on an individual and crew basis and can evolve away from the intent of operation. This category of requirements ensures activities are performed such that the intent of the operation is being met.

Requirements and Intent

3.3.1 System functions shall be monitored to reinforce expectations for work performance and facility condition.

3.3.1a Conduct of Operation principles shall be applied to functions and operations within the system, to ensure the performance of actions accomplishes the intent. [10 CFR 830.120]

3.3.1b Performance shall be periodically monitored and assessed, to determine that the intent of the operation is being fully met. [10 CFR 830.120]

5.4 REQUIREMENTS TO EVALUATE AND MONITOR CONTAINMENT INTEGRITY

5.4.1 Monitor Containment Integrity

MO 4, Requirement Category 1: Containment integrity will be monitored to ensure the status of the condition of cylinders and storage facilities are safe and the surrounding environment not impacted to beyond standards.

Description and Rationale

Cylinders are the integral component in the storage phase of the Project. They are used to contain the UF_6 inventory and provide the primary barrier between the UF_6 and worker, public, and the environment. Actions performed on these cylinders are outlined in the system definition discussed in Sect. 4.2.3. In order to ensure this integral component performs as desired within each function and within subsequent phases of the Project (disposition and decommissioning), functional criteria for cylinders are necessary. These functional criteria will establish the minimum integrity necessary to safely perform operations using routine controls.

The cylinders in service were designed to ASME pressure vessel standards. All, except a small population, were manufactured to ASME standards and are code-stamped as such. Other standards related to the in-service use of UF_6 cylinders include ANSI and DOT standards for packaging and transport, and DOE USEC-651[13] for contents transfer. It is expected that, because of past storage practices, an undetermined number of cylinders do not comply with these standards. The primary cause of non-compliance is external corrosion resulting in cylinder wall thicknesses less than minimum standard thicknesses, and code stamped nameplates being displaced from cylinders. Data collected and preliminary analyses to date show these cylinders still have adequate structural integrity for continued storage of the UF_6 in the yards. Additionally, preliminary analyses show that non-compliant cylinder conditions are also safe for other functional operations. Project objectives discussed in Sect. 3.4 provide the emphasis to mitigate further deterioration of the cylinders and thus control the increase in the non-compliant population of cylinders.

It is the intent of the Project to maintain compliance with industry standards applicable to UF_6 containers. This intent preserves the flexibility in the current storage phase and in the subsequent UF_6 dispositioning phase. However, substandard cylinders may be a candidate for near-term corrective action.

This category of requirements defines the standards by which non-conforming and non-compliant cylinders can be identified. An evaluation will be performed to determine minimum safe criteria for each system function. These minimum safe criteria in conjunction with an inspection and evaluation scheme enable the determination of the acceptability of individual cylinders and will provide the basis for an exception case to be presented to the standards organizations. The approved exception case will provide criteria for managing cylinders that do not meet current standards. Additional controls may be needed, to obtain an exception from the standards. Standards within the current phase and subsequent phases may dictate development of actions to upgrade the cylinders to standards.

Approved exceptions to standards, in conjunction with necessary additional controls, will be obtained before cylinders are processed through operational functions governed by industry standards.

Defense in depth principles are applied in the monitoring of containment integrity. The first line of defense is the monitoring of cylinder degradation factors to predict the cylinder deterioration rates and proactively plan out-year maintenance. These degradation factors are evaluated and monitored on a graded approach. The second line of defense is the monitoring of cylinder degradation and storage yard conditions. These activities provide information to implement near-term preventive and corrective maintenance. Cylinder acceptance criteria and storage facility performance criteria are used in the development of monitoring procedures. The last line of defense is monitoring of cylinder containment and signs of loss of containment to the storage facility and surrounding environment.

This monitoring identifies when remedial actions are necessary. The typical method for monitoring of loss of containment is through radiation surveys. Monitoring of the environment for compliance with release limits is part of the last line of defense. Monitoring containment integrity will be performed through graded method(s) on risk-based periodicity.

Requirements and Intent

The following Project requirements are established to monitor containment integrity.

4.1.1 Exposure to the environment shall be monitored.

4.1.1a Environmental monitoring actions within the storage phase shall be balanced with potential environmental remediation in the decommissioning phase. [Derived]

4.1.1b Facilities shall be regularly surveyed for radiation and release of UF_6 and reaction products to evaluate Project risks. [10 CFR 835, DOE 5480.23]

4.1.2 Cylinder condition shall be monitored.

4.1.2a Cylinder functional acceptance criteria shall be defined to ensure safe operations within each system function. [10 CFR 830.120, 10 CFR 835, DOE 5480.23, USEC-651]

4.1.2b The applicability of industry standards, including ANSI 14.1 and ASME Code[1] to operational functions shall be established. [10 CFR 830.120, 10 CFR 835, 49 CFR 173.420, DOE 5480.23, USEC-651]

4.1.2c Exceptions, as necessary, shall be obtained to maintain adherence with industry standards. [NBIC]

4.1.2d Inspection/evaluation methods for verifying compliance with functional acceptance criteria shall be developed and implemented to identify unsafe cylinders. [10 CFR 830.120, USEC-651, NBIC]

4.1.2e Cylinders shall be inspected on a risk-based periodicity to detect loss of containment. [DF&O]

4.1.2f Cylinders shall be properly spaced to facilitate inspection. [10 CFR 835, 10 CFR 830.120, USEC-651]

4.1.3 Factors that affect cylinder condition shall be monitored.

4.1.3a Environmental and other factors affecting cylinder integrity shall be identified and evaluated to determine their effect (e.g., localized corrosion mechanisms that involve crevice, galvanic, packing nut, and hydrogen fluoride–related corrosion; corrosion under channel-type stiffeners and head/skirt region; impact of brittle fracture on cylinder storage). This evaluation determines what factors need to be monitored for proactive management and preventive measures. The rigor of this comprehensive evaluation is based on the degree of effect on the containment integrity. [DOE 5480.23, DOE 6430.1A]

4.1.3b Cylinder degradation factors shall be monitored to collect forecasting and trending data. [10 CFR 830.120]

5.4.2 Evaluate Containment Integrity

MO 4, Requirement Category 2: Evaluate containment integrity to determine cylinder conditions and predict future conditions.

Description and Rationale

The system includes about 55,000 cylinders in various physical conditions. This category of requirements ensures information generated is assimilated for use in guiding Project decisions.

To ensure a safe configuration, the cylinder conditions must be known and monitored for adherence to specified standards. This category of requirements establishes the means for determining the condition of the cylinders with respect to acceptance criteria based on the cylinder and degradation monitoring data. The forecasting of cylinder conditions is also a part of this requirement category.

Requirements and Intent

The following Project requirements ensure cylinder conditions and acceptability are known.

4.2.1 Cylinders shall be categorized to ensure that risks are identified.

4.2.2 Cylinder conditions shall be forecast to direct surveillance and maintenance resources.

4.2.2a Specific information, as determined by the Project, shall be tracked to project the current and future conditions of the system. [10 CFR 830.120, DOE 4700.1]

4.2.2b Mechanisms to consolidate information for summary level decision-making determinations shall be developed. [10 CFR 830.120, DOE 4700.1]

5.5 REQUIREMENTS TO ADMINISTER THE SYSTEM

5.5.1 Obtain Resources

MO 5, Requirement Category 1: Obtain resources to operate the system.

Description and Rationale

An integral system function is to obtain and deploy adequate resources for achieving the Project mission and major objectives. These resources include the financial, capital, and intellectual capabilities to comply with stated operational requirements.

Requirements and Intent

The following system requirements focus on obtaining the necessary resources to operate a safe system.

5.1.1 Financial resources to sustain the system shall be obtained and utilized.

5.1.2 Intellectual resources (operational, technical, financial expertise) to sustain the system shall be secured.

5.5.2 Integrate System Operations

MO 5, Requirement Category 2: Integrate the system operations.

Description and Rationale

The system must be integrated to operate efficiently and effectively. Effective integration is established through the analysis of interface performance specifications and the traceability of requirements to the operational activities. This traceability must be keep current with evolving standards. The analysis of interface performance specifications is also a component of developing and controlling the system configuration discussed in requirement Category 1.1. To efficiently operate the system the configuration must be optimized. Optimization activities include operational logistics planning, and the identification and incorporation of new technologies and methods to reduce risks, time, and financial needs.

Requirements and Intent

The following system requirements are provided to integrate the system operations.

5.2.1 System and technical requirements shall be traceable from the Project mission to implementing documentation.

5.2.2 The system configuration shall be optimized in accordance with life-cycle projections.

5.2.2a Impact on the subsequent Project phases shall be considered in changes to the system configuration including modifications to accommodate regulatory changes. [10 CFR 830.120, DOE 5480.19]

5.2.2b The planning for UF_6 dispositioning shall take into consideration the condition of cylinders and compensatory actions to accomplish disposition operations. [10 CFR 830.120]

5.2.2c As part of continuous improvement, other methods for reducing time of wetness and cylinder degradation shall be evaluated. [10 CFR 830.120, 10 CFR 835]

6. NEXT STEPS

The requirements specified herein are used as the basis for identifying necessary Project activities or changes in activities necessary to accomplish the Project mission. The stated intent and rationale for the requirements have been provided in sufficient detail to ensure the utility of this SRD in comprehensive development of Project activities. Activities are developed based on a requirements analysis conducted with participation from operating personnel and subject matter experts. These activities are identified and developed through the decision-making process documented in the SEMP and carried out in the EDP and PMP.

REFERENCES

1. "Rules for Construction of Pressure Vessels," *American Society of Mechanical Engineers Boiler and Pressure Vessel Code*, Sec. VIII, Div. 1, ASME, New York, 1995.

2. E. J. Barber et al., *Investigation of Breached Depleted UF_6 Cylinders*, POEF-2086, ORNL/TM-11988, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., September 1991.

3. E, J. Barber, *Investigation of Breached Depleted UF_6 Cylinders at the K-25 Site*, K/ETO-155, ORNL/TM-12840, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., October 1994.

4. M. S. Taylor et al., *Long-Term Storage Cylinder Integrity Management Plan*, K/ETO-114, Uranium Enrichment Organization, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn., September 1992.

5. *Recommendation 95-1 to the Secretary of Energy pursuant to 42 U.S.C. § 2286a(5)*, Atomic Energy Act of 1954, as amended, Defense Nuclear Facilities Safety Board, May 5, 1995.

6. H. R. O'Leary, U.S. Department of Energy, *Implementation Plan*, letter to J. T. Conway, Defense Nuclear Facilities Safety Board, October 16, 1995.

7. *UF_6 Cylinder Project Systems Engineering Management Plan*, K/TSO-017, Rev.2, Project Support Organization, Lockheed Martin Energy Systems, Inc., July 1997.

8. *UF_6 Cylinder Project Engineering Development Plan,* K/TSO-28, Rev. 2, Project Support Organization, Lockheed March Energy Systems, Inc., July 1997.

9. *UF_6 Cylinder Project Management Plan,* K/TSO-30, Rev. 2, Project Support Organization, Lockheed Martin Energy Systems, Inc., July 1997.

10. *Safety Analysis Report, Paducah Gaseous Diffusion Plant*, KY/EM-257, Lockheed Martin Energy Systems, Inc., March 30, 1998

11. *Safety Analysis Report, Portsmouth Gaseous Diffusion Plant*, POEF-LMES-185, Lockheed Martin Energy Systems, Inc., March 30, 1998.

12. Letter to L. P. Duffy from P. G. Sewell, *Plans for Ultimate Disposition of Depleted Uranium,* February 20, 1992.

13. USEC-651, Rev. 7, *Uranium Hexafluoride: A Manual of Good Handling Practices,* U.S. Department of Energy, January 1995.

14. *K-25 Site UF_6 Cylinder Storage Yards Final Safety Analysis Report,* K/D-SAR-29, Rev. 1, Lockheed Martin Energy Systems, Inc., May 1998.

APPENDIX A

APPLICABLE ES&H STANDARDS

(includes UF_6 Cylinder Project, Phase II, and Engineering Design and Construction)

Work Smart Standards for the UF6 Cylinder Project

DWG. NO. K/G 96-2410-R1

Work Smart Standards	Hazard Categories: Environmental (EP)	Industrial Hygiene (IH)	Industrial Safety (IS)	Nuclear Safety (NS)	Radiological Protection (RP)	
10 CFR 830.120* Quality Assurance Requirements	X	X	X	X	X	
10 CFR 835 Subpart B - Radiation Protection Program					X	
10 CFR 835 Subpart C - Standards for Internal and External Exposure		X			X	
10 CFR 835 Subpart E - Monitoring in the Workplace		X			X	
10 CFR 835 Subpart F - Entry Control Program					X	
10 CFR 835 Subpart G - Posting and Labeling		X			X	
10 CFR 835 Subpart H - Records		X			X	
10 CFR 835 Subpart J - Radiation Safety Training		X			X	
10 CFR 835 Subpart K - Design and Control		X			X	
10 CFR 835 Subpart L - Release of Materials and Equipment from Radiological Areas		X			X	
10 CFR 1021* National Environmental Policy Act Implementation Procedures	X					
10 CFR 1022* Compliance with Floodplain/Wetlands Environmental Review Requirements	X					
29 CFR 1910 Subpart C - General Safety and Health Provisions		X	X			
29 CFR 1910 Subpart D - Walking Working Surfaces			X			
29 CFR 1910 Subpart E - Means of Egress			X			
29 CFR 1910 Subpart F - Powered Platforms, Manlifts and Vehicle Mounted Work Platforms			X			
29 CFR 1910 Subpart G - Occupational Health and Environmental Controls		X	X		X	
29 CFR 1910 Subpart H - Hazardous Materials		X	X		X	
29 CFR 1910 Subpart I - Personal Protective Equipment		X	X			
29 CFR 1910 Subpart J - General Environmental Controls		X	X			
29 CFR 1910 Subpart K - Medical and First Aid		X	X			
29 CFR 1910 Subpart M - Fall Protection			X			
29 CFR 1910 Subpart N - Materials Handling and Storage			X			
29 CFR 1910 Subpart O - Machinery and Machine Guarding			X			
29 CFR 1910 Subpart P - Hand and Portable Powered Tools and Other Hand Held Equipment			X			
29 CFR 1910 Subpart Q - Welding, Cutting and Brazing		X	X			
29 CFR 1910 Subpart S - Electrical			X			
29 CFR 1910 Subpart Z - Toxic and Hazardous Substances		X	X			
29 CFR 1926 Subpart C - General Safety and Health Provisions		X	X			
29 CFR 1926 Subpart D - Occupational Health and Environmental Controls		X	X		X	
29 CFR 1926 Subpart E - Personal Protective and Lifesaving Equipment		X	X			
29 CFR 1926 Subpart H - Materials Handling, Storage, Use and Disposal			X			
29 CFR 1926 Subpart I - Tools, Hand and Power			X			
29 CFR 1926 Subpart J - Welding and Cutting		X	X			
29 CFR 1926 Subpart K - Electrical		X	X			
29 CFR 1926 Subpart N - Cranes, Derricks, Hoists, Elevators, and Conveyors			X			
29 CFR 1926 Subpart O - Motor Vehicles, Mechanized Equipment and Marine Operations			X			
29 CFR 1926 Subpart P - Excavations		X	X			

*Additions to Table 7 (September 1996)

Work Smart Standards for the UF6 Cylinder Project (Cont'd)

DWG. NO. K/G 96-2410-R1-A

Work Smart Standards	Hazard Categories: Environmental (EP)	Industrial Hygiene (IH)	Industrial Safety (IS)	Nuclear Safety (NS)	Radiological Protection (RP)	
29 CFR 1926 Subpart V - Power Transmission and Distribution			X			
29 CFR 1926 Subpart W - Rollover Protective Structures: Overhead Protection			X			
American Conference of Government Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) and Biological Exposure Indices		X			X	
OAC 1501:15-1 Urban Sediment Pollution Abatement Rules	X					
KRS 224.01-400 Environmental Emergencies: Reportable quantities and release notification requirements for hazardous substances, pollutants, or contaminants - Variation of requirements by administrative regulations - Emergency Plan - Powers of cabinet - Remedial action to restore environment - Lien of cabinet for costs of cleanup - Liability of financial institution acquiring property of serving fiduciary	X					
KRS 224.16-050 Issuance of Federal Permits by Cabinet	X					
ORC 3714 Construction and Demolition Debris	X					
ORC 3734 Solid and Hazardous Wastes	X					
OAC 3745-15 General Provisions on Air Pollution	X					
OAC 3745-17 Particular Matter Standards	X					
OAC 3745-27 Solid Waste Disposal Regulations	X					
OAC 3745-29 Industrial Solid Waste Landfill Facilities	X					
OAC 3745-31 Permit to Install New Sources of Pollution	X					
OAC 3745-32 Section 401 Water Quality Certifications	X					
OAC 3745-33 Ohio NPDES Permits	X					
OAC 3745-35 Air Permits to Operate and Variances	X					
OAC 3745-50 Hazardous Waste Rules - General Provisions	X					
OAC 3745-51 Hazardous Wastes Subject to Regulation	X					
OAC 3745-52 Generators of Hazardous Waste	X					
OAC 3745-53 Transporters of Hazardous Wastes	X					
OAC 3745-54 Standards for the Management of Hazardous Wastes	X					
OAC 3745-55 Management of Hazardous Wastes: Closure and Post Closure	X					
OAC 3745-59 Hazardous Wastes - Land Disposal - Prohibitions and Restrictions	X					
OAC 3750-20 Emergency Planning	X					
OAC 3750-25 Emergency Release Notification	X					
OAC 3750-30 Hazardous Chemical Reporting	X					
Ohio Revised Code, Section 6111 Water Standards	X					
T.C.A. 68-211-803.(b)	X					
33 CFR 320 General Regulatory Policies	X					
33 CFR 323 Permits for Discharge of Dredged or Fill Material into Waters of the United States	X					
33 CFR 325 Processing of Department of the Army Permits	X					
33 CFR 328 Definitions of Waters of the United States	X					
33 CFR 329 Definitions of Navigable Waters of the United States	X					

*Additions to Table 7 (September 1996)

Work Smart Standards for the UF6 Cylinder Project (Cont'd)

DWG. NO. K/G 96-2410-R1-B

Work Smart Standards		Environmental (EP)	Industrial Hygiene (IH)	Industrial Safety (IS)	Nuclear Safety (NS)	Radiological Protection (RP)
33 CFR 330	Nationwide Permit System	X				
36 CFR 60*	National Register of Historic Places	X				
36 CFR 63*	Determination of Eligibility for Inclusion in the National Historic Places	X				
36 CFR 65*	National Historic Landmarks Program	X				
36 CFR 78*	Waiver of Federal Agency Responsibilities under 110 of NHPA	X				
36 CFR 79*	Curation of Federally Owned and Administrated Archaeological Collection	X				
36 CFR 800*	Protection of Historic and Cultural Properties	X				
40 CFR 50*	National Primary and Secondary Ambient Air Quality Standards	X				
40 CFR 53*	Ambient Air Monitoring Reference and Equivalent Methods	X				
40 CFR 58*	Ambient Air Quality Surveillance	X				
40 CFR 60*	Standards of Performance for New Stationary Sources	X				
40 CFR 61*	National Emission Standards for Hazardous Air Pollutants	X				
40 CFR 63*	National Emission Standards for Hazardous Air Pollutants for Source Categories	X				
40 CFR 68*	Chemical Accident Prevention Provisions	X				
40 CFR 69*	Special Exemptions from Requirements of the Clean Air Act	X				
40 CFR 70*	State Operating Permit Programs	X				
40 CFR 71*	Federal Operating Permit Program	X				
40 CFR 72*	Permit Regulations	X				
40 CFR 81*	Designation of Areas for Air Quality Planning Purposes	X				
40 CFR 82*	Protection of Stratospheric Ozone	X				
40 CFR 85*	Control of Air Pollution from Motor Vehicles and Motor Vehicle Engines	X				
40 CFR 86*	Control of Air Pollution from New and In-use Motor Vehicles and New and In-use Motor Vehicle Engines: Certification and Test Procedures	X				
40 CFR 89*	Control of Emissions from New and In-use Nonroad Engines	X				
40 CFR 90*	Control of Emissions from Nonroad Spark-ignition Engines	X				
40 CFR 104*	Public Hearings on Effluent Standards for Toxic Pollutants	X				
40 CFR 108*	Employee Protection Hearings	X				
40 CFR 110	Discharge of Oil	X				
40 CFR 112	Oil Pollution Prevention	X				
40 CFR 116*	Designation of Hazardous Substances	X				
40 CFR 117*	Determination of Reportable Quantities for Hazardous Substances	X				
40 CFR 122	EPA Administered Permit Programs: The National Pollutant Discharge Elimination System	X				
40 CFR 129*	Toxic Pollutant Effluent Standards	X				
40 CFR 131*	Water Quality Standards	X				
40 CFR 156*	Labeling Requirements for Pesticides and Devices	X				
40 CFR 171*	Certification of Pesticide Application	X				
40 CFR 232*	404 Program Definitions: Exempt Activities Not Requiring 404 Permits	X				

*Additions to Table 7 (September 1996)

Work Smart Standards for the UF6 Cylinder Project (Cont'd)

DWG. NO. K/G 96-2410-R1-C

Work Smart Standards		Environmental (EP)	Industrial Hygiene (IH)	Industrial Safety (IS)	Nuclear Safety (NS)	Radiological Protection (RP)	
		Hazard Categories					
40 CFR 246	Source Separation for Materials Recovery Guidelines	X					
40 CFR 255*	Corps of Engineers Dredged Material Permits	X					
40 CFR 260*	Hazardous Waste Management System: General	X					
40 CFR 261	Identification and Listing of Hazardous Waste	X					
40 CFR 262	Standards Applicable to Generators of Hazardous Waste	X					
40 CFR 263	Standards Applicable to Transporters for Hazardous Waste	X					
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	X					
40 CFR 265*	Interim Status Standards for Owners and Operations of Hazardous Waste Treatment, Storage, and Disposal Facilities	X					
40 CFR 266*	Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities	X					
40 CFR 268	Land Disposal Restrictions	X					
40 CFR 273*	Standards for Universal Waste Management	X					
40 CFR 279*	Standards for the Management of Used Oil	X					
40 CFR 300*	National Oil and Hazardous Substances Pollution Contingency Plan	X					
40 CFR 302	Designation, Reportable Quantities, and Notification	X					
40 CFR 355*	Facility Notification and Release Reporting Requirements	X					
40 CFR 370*	Hazardous Chemical Inventory Reporting Requirements	X					
40 CFR 372*	Toxic Release Reporting Requirements	X					
40 CFR 761*	Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions	X					
40 CFR 1500-1508*	Council on Environmental Quality	X					
43 CFR 7*	Protection of Archaeological Resources	X					
49 CFR 171*	General Information, Regulations, and Definitions	X					
49 CFR 172*	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information and Training	X					
49 CFR 173*	Subpart I - Class 7 (Radioactive) Materials	X					
401 KAR 4*	Water Resources	X					
401 KAR 5	Water Quality	X					
401 KAR 5:031	Surface Water Standards	X					
401 KAR 5:055	KPDES Permit	X					
401 KAR 30	General Administrative Procedures	X					
401 KAR 31	Identification and Listing of Hazardous Waste Standards Applicable to Generators of Hazardous Waste	X					
401 KAR 32	Standards Applicable to Generators of Hazardous Waste	X					
401 KAR 33	Standards Applicable to Transporters of Hazardous Waste	X					

*Additions to Table 7 (September 1996)

Work Smart Standards for the UF6 Cylinder Project (Cont'd)

DWG. NO. K/G 96-2410-R2-D

Work Smart Standards		Environmental (EP)	Industrial Hygiene (IH)	Industrial Safety (IS)	Nuclear Safety (NS)	Radiological Protection (RP)
401 KAR 34	Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities	X				
401 KAR 35	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities	X				
401 KAR 36	Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities	X				
401 KAR 37	Land Disposal Restrictions	X				
401 KAR 38	Hazardous Waste Permitting Process	X				
401 KAR 39	Hazardous Waste Fees	X				
401 KAR 40	Enforcement and Compliance Monitoring Hazardous Waste	X				
401 KAR 47	Solid Waste Facilities	X				
401 KAR 48	Standards for Solid Waste Facilities	X				
401 KAR 50	General Administrative Procedures	X				
401 KAR 51*	New Source Requirements: Nonattainment Areas	X				
401 KAR 53*	Ambient Air Quality	X				
401 KAR 57*	Hazardous Pollutants	X				
401 KAR 59	New Source Standards	X				
401 KAR 61*	Existing Source Standards	X				
401 KAR 63	General Standards of Performance	X				
ANS 8.1	Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors				X	
ANS 8.3	Criticality Accident Alarm System				X	
ANS 8.7	Guide for Nuclear Criticality Safety in Storage of Fissile Materials				X	
ANS 8.19	Administrative Practices for Nuclear Criticality Safety				X	
ANS 8.20	Nuclear Criticality Safety Training				X	
ANSI Z117.1	Safety Requirements for Confined Spaces, 1995		X	X		
ANSI Z136.1-1993:	Safety Use of Lasers		X	X		
DOE N441.3	Radiological Protection for DOE Activities					X
DOE 5400.5*	Radiation Protection of the Public and the Environment (Until superseded by 10 CFR 824)	X				
DOE 5480.21*	Unreviewed Safety Questions				X	
DOE 5840.22*	Technical Safety Requirements				X	
DOE 5480.23*	Nuclear Safety Analysis Reports				X	
DOE 5820.2A*	Radioactive Waste Management	X				
NIOSH 1981	Work Practice Guide for Manual Lifting			X		
TDEC 1200-1-7*	Solid Waste Disposal System	X				
TDEC 1200-1-11.01*	Hazardous Waste Management System: General	X				
TDEC 1200-1-11.02*	Identification and Listing of Hazardous Waste	X				

*Additions to Table 7 (September 1996)

Work Smart Standards for the UF6 Cylinder Project (Cont'd)

DWG. NO. K/G 96-2410-R3-E

Work Smart Standards		Environmental (EP)	Industrial Hygiene (IH)	Industrial Safety (IS)	Nuclear Safety (NS)	Radiological Protection (RP)	
TDEC 1200-1-11.03*	Notification Requirements and Standards Applicable to Generators of Hazardous Wastes	X					
TDEC 1200-1-11.04*	Permit Requirements and Standards Applicable to Transporters of Hazardous Waste	X					
TDEC 1200-1-11.06*	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	X					
TDEC 1200-1-11.10*	Land Disposal Restriction	X					
TDEC 1200-3-1*	General Provisions	X					
TDEC 1200-3-2*	Definitions	X					
TDEC 1200-3-3*	Ambient Air Quality Standards	X					
TDEC 1200-3-5*	Visible Emissions	X					
TDEC 1200-3-6*	Non-Process Emissions Standards	X					
TDEC 1200-3-8*	Fugitive Dust	X					
TDEC 1200-3-9*	Construction and Operating Permits	X					
TDEC 1200-3-11*	Hazardous Air Contaminants	X					
TDEC 1200-3-16*	New Source Performance Standards	X					
TDEC 1200-3-18*	Volatile Organic Compounds	X					
TDEC 1200-3-20*	Limits on Emissions Due to Malfunctions, Start-ups and Shutdowns	X					
TDEC 1200-3-22*	Lead Emission Standards	X					
TDEC 1200-3-26*	Administrative Fee Schedule	X					
TDEC 1200-4-1*	General Water Quality Provisions	X					
TDEC 1200-4-3*	Tennessee Water Quality Standard	X					
TDEC 1200-4-10*	Tennessee NPDES Permit Regulation	X					
ANSI1ASMEB31	National Boiler Inspection Code			X			
ASME Boiler and Pressure Vessel Code				X			

*Additions to Table 7 (September 1996)

APPENDIX B

ALLOCATION OF APPLICABLE STANDARDS TO REQUIREMENT CATEGORIES

Allocation of Applicable Standards to Requirement Categories

Standards		Define Safety Envelope	Operate Within Safety Envelope	Mitigate Deterioration of Cylinders	Mitigate Damage to Cylinders	Manage Non-Compliant Cylinders	Improve Process Controls	Improve Staffing and Training	Monitor System Performance	Monitor Containment Integrity	Evaluate Containment Integrity	Obtain Resources	Integrate System Operations	
10 CFR 830.120*	Quality Assurance Requirements	X	X	X	X	X	X	X	X	X	X		X	
10 CFR 835 Subpart B -	Radiation Protection Program	X	X			X			X	X	X			
10 CFR 835 Subpart C -	Standards for Internal and External Exposure	X	X											
10 CFR 835 Subpart E -	Monitoring in the Workplace	X	X											
10 CFR 835 Subpart F -	Entry Control Program	X	X											
10 CFR 835 Subpart G -	Posting and Labeling	X	X											
10 CFR 835 Subpart H -	Records	X	X											
10 CFR 835 Subpart J -	Radiation Safety Training	X	X											
10 CFR 835 Subpart K -	Design and Control	X	X											
10 CFR 835 Subpart L -	Release of Materials and Equipment from Radiological Areas	X	X											
10 CFR 1021*	National Environmental Policy Act Implementation Procedures			X										
10 CFR 1022*	Compliance with Floodplain/Wetlands Environmental Review Requirements			X										
29 CFR 1910 Subpart C -	General Safety and Health Provisions	X	X		X		X							
29 CFR 1910 Subpart D -	Walking Working Surfaces	X	X		X	X	X							
29 CFR 1910 Subpart E -	Means of Egress	X	X		X	X	X							
29 CFR 1910 Subpart G -	Powered Platforms, Manlifts, and Vehicle Mounted Work Platforms	X	X		X	X	X							
29 CFR 1910 Subpart H -	Hazardous Materials	X	X				X							
29 CFR 1910 Subpart I -	Personal Protective Equipment	X	X			X	X							
29 CFR 1910 Subpart J -	General Environmental Controls	X	X	X	X		X							
29 CFR 1910 Subpart K -	Medical and First Aid	X	X											
29 CFR 1910 Subpart M -	Fall Protection	X	X				X							
29 CFR 1910 Subpart N -	Materials Handling and Storage	X	X				X							
29 CFR 1910 Subpart O -	Machinery and Machine Guarding	X	X				X							
29 CFR 1910 Subpart P -	Hand and Portable Powered Tools and Other Hand-Held Equipment	X	X				X							
29 CFR 1910 Subpart Q -	Welding, Cutting and Brazing	X	X				X							
29 CFR 1910 Subpart S -	Electrical	X	X				X							
29 CFR 1910 Subpart Z -	Toxic and Hazardous Substances	X	X				X							
29 CFR 1926 Subpart C -	General Safety and Health Provisions	X	X				X							
29 CFR 1926 Subpart D -	Occupational Health and Environmental Controls	X	X				X							
29 CFR 1926 Subpart E -	Personal Protective and Lifesaving Equipment	X	X				X							
29 CFR 1926 Subpart H -	Materials Handling, Storage, Use and Disposal	X	X				X							
29 CFR 1926 Subpart I -	Tools, Hand and Power	X	X				X							
29 CFR 1926 Subpart J -	Welding and Cutting	X	X				X							
29 CFR 1926 Subpart K -	Electrical	X	X				X							
29 CFR 1926 Subpart N -	Cranes, Derricks, Hoists, Elevators, and Conveyors	X	X				X							
29 CFR 1926 Subpart O -	Motor Vehicles, Mechanized Equipment and Marine Operations	X	X				X							
29 CFR 1926 Subpart P -	Excavations	X	X				X							
29 CFR 1926 Subpart V -	Power Transmission and Distribution				X									

*Additions to Table 7 (September 1996)

DWG. NO. K/GA 97-1164-R2(A)

Allocation of Applicable Standards to Requirement Categories

Standards		Define Safety Envelope	Operate Within Safety Envelope	Mitigate Deterioration of Cylinders	Mitigate Damage to Cylinders	Manage Non-Complaint Cylinders	Improve Process Controls	Improve Staffing and Training	Monitor System Performance	Monitor Containment Integrity	Evaluate Containment Integrity	Obtain Resources	Integrate System Operations
29 CFR 1926 Subpart W -Rollover Protective Structures: Overhead Protection			X				X						
American Conference of Government Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) and Biological Exposure Indices			X										
OAC 1501:15-1	Urban Sediment Pollution Abatement Rules		X										
KRS 224.01-400	Environmental Emergencies: Reportable quantities and release notification requirements for hazardous substances, pollutants, or contaminants - Variation of requirements by administrative regulations - Emergency Plan - Powers of cabinet - Remedial action to restore environment - Lien of cabinet for costs of cleanup - Liability of financial institution acquiring property of serving fiduciary		X										
KRS 224.16-050	Issuance of Federal Permits by Cabinet			X									
ORC 3714	Construction and Demolition Debris		X										
ORC 3734	Solid and Hazardous Wastes	X	X										
OAC 3745-15	General Provisions on Air Pollution	X	X										
OAC 3745-17	Particular Matter Standards	X	X										
OAC 3745-27	Solid Waste Disposal Regulations	X	X										
OAC 3745-29	Industrial Solid Waste Landfill Facilities	X	X										
OAC 3745-31	Permit to Install New Sources of Pollution	X	X										
OAC 3745-32	Section 401 Water Quality Certifications	X	X										
OAC 3745-33	Ohio NPDES Permits	X	X										
OAC 3745-35	Air Permits to Operate and Variances	X	X										
OAC 3745-50	Hazardous Waste Rules - General Provisions	X	X										
OAC 3745-51	Hazardous Wastes Subject to Regulation	X	X										
OAC 3745-52	Generators of Hazardous Waste	X	X										
OAC 3745-53	Transporters of Hazardous Wastes	X	X										
OAC 3745-54	Standards for the Management of Hazardous Wastes	X	X										
OAC 3745-55	Management of Hazardous Wastes: Closure and Post Closure	X	X										
OAC 3745-59	Hazardous Wastes - Land Disposal - Prohibitions and Restrictions			X									
OAC 3750-20	Emergency Planning			X	X	X				X	X		
OAC 3750-25	Emergency Release Notification				X	X				X			
OAC 3750-30	Hazardous Chemical Reporting	X	X										
Ohio Revised Code, Section 6111 Water Standards		X	X										
33 CFR 320	General Regulatory Policies	X	X										X
33 CFR 323	Permits for Discharge of Dredged or Fill Material into Waters of the United States												X
33 CFR 325	Processing of Department of the Army Permits												X
33 CFR 328	Definitions of Waters of the United States												X
33 CFR 329	Definitions of Navigable Waters of the United States												X
33 CFR 330	Nationwide Permit System												X
36 CFR 60*	National Register of Historic Places												X

*Additions to Table 7 (September 1996)

DWG. NO. K/GA 97-1164-R2(B)

DWG. NO. K/GA-97-1164-R2(C)

Allocation of Applicable Standards to Requirement Categories

Standards		Define Safety Envelope	Operate Within Safety Envelope	Mitigate Deterioration of Cylinders	Mitigate Damage to Cylinders	Manage Non-Complaint Cylinders	Improve Process Controls	Improve Staffing and Training	Monitor System Performance	Monitor Containment Integrity	Evaluate Containment Integrity	Obtain Resources	Integrate System Operations
36 CFR 63*	Determination of Eligibility for Inclusion in the National Historic Places												X
36 CFR 65*	National Historic Landmarks Program												X
36 CFR 78*	Waiver of Federal Agency Responsibilities under 100 of NHPA												X
36 CFR 79*	Curation of Federally Owned and Administrated Archaeological Collection												X
36 CFR 800*	Protection of Historic and Cultural Properties												X
40 CFR 50*	National Primary and Secondary Ambient Air Quality Standards												X
40 CFR 53*	Ambient Air Monitoring Reference and Equivalent Methods	X	X										
40 CFR 58*	Ambient Air Quality Surveillance	X	X										
40 CFR 60*	Standards of Performance for New Stationary Sources	X	X										
40 CFR 61*	National Emission Standards for Hazardous Air Pollutants	X	X										
40 CFR 63*	National Emission Standards for Hazardous Air Pollutants for Source Categories	X	X										
40 CFR 68*	Chemical Accident Prevention Provisions	X	X										
40 CFR 69*	Special Exemptions from Requirements of the Clean Air Act	X	X										
40 CFR 70*	State Operating Permit Programs	X	X										
40 CFR 71*	Federal Operating Permit Program	X	X										
40 CFR 72*	Permit Regulations		X										
40 CFR 81*	Designation of Areas for Air Quality Planning Purposes			X									
40 CFR 82*	Protection of Stratospheric Ozone	X	X										
40 CFR 85*	Control of Air Pollution from Motor Vehicles and Motor Vehicle Engines	X	X										
40 CFR 86*	Control of Air Pollution from New and In-use Motor Vehicles and New and In-use Motor Vehicle Engines: Certification and Test Procedures	X	X										
40 CFR 89*	Control of Emissions from New and In-use Nonroad Engines	X	X										
40 CFR 90*	Control of Emissions from Nonroad Spark-ignition Engines	X	X										
40 CFR 104*	Public Hearings on Effluent Standards for Toxic Pollutants												X
40 CFR 108*	Employee Protection Hearings												X
40 CFR 110	Discharge of Oil	X	X										
40 CFR 112	Oil Pollution Prevention	X	X										
40 CFR 116*	Designation of Hazardous Substances	X	X										
40 CFR 117*	Determination of Reportable Quantities for Hazardous Substances	X	X										
40 CFR 122	EPA Administered Permit Programs: The National Pollutant Discharge Elimination System	X	X										
40 CFR 129*	Toxic Pollutant Effluent Standards	X	X										
40 CFR 131*	Water Quality Standards	X	X										
40 CFR 156*	Labeling Requirements for Pesticides and Devices	X	X										
40 CFR 171*	Certification of Pesticide Application												X
40 CFR 232	404 Program Definitions: Exempt Activities Not Requiring 404 Permits												X
40 CFR 246	Source Separation for Materials Recovery Guidelines												X
40 CFR 255*	Corps of Engineers Dredged Material Permits												X

*Additions to Table 7 (September 1996)

Allocation of Applicable Standards to Requirement Categories

Standards		Define Safety Envelope	Operate Within Safety Envelope	Mitigate Deterioration of Cylinders	Mitigate Damage to Cylinders	Manage Non-Complaint Cylinders	Improve Process Controls	Improve Staffing and Training	Monitor System Performance	Monitor Containment Integrity	Evaluate Containment Integrity	Obtain Resources	Integrate System Operations
40 CFR 260*	Hazardous Waste Management Permits	X	X										
40 CFR 261	Identification and Listing of Hazardous Waste	X	X										
40 CFR 262	Standards of Applicable to Generators for Hazardous Waste	X	X										
40 CFR 233	Standards of Applicable to Transporters for Hazardous Waste												X
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities												X
40 CFR 265*	Interim Status Standards for Owners and Operations of Hazardous Waste Treatment, Storage, and Disposal Facilities												X
40 CFR 266*	Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities												X
40 CFR 268*	Land Disposal Restrictions	X	X										
40 CFR 273*	Standards for Universal Waste Management												X
40 CFR 279*	Standards for the Management of Used Oil	X	X										
40 CFR 300*	National Oil and Hazardous Substances Pollution Contingency Plan	X	X										
40 CFR 302	Designation, Reportable Quantities, and Notification	X	X										
40 CFR 355*	Facility Notification and Release Reporting Requirements	X	X										
40 CFR 370*	Hazardous Chemical Inventory Reporting Requirements	X	X										
40 CFR 372*	Toxic Release Reporting Requirements	X	X										
40 CFR 761*	Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions												X
40 CFR 1500-1508*	Council on Environmental Quality												X
43 CFR 7*	Protection of Archaeological Resources												X
49 CFR 171*	General Information, Regulations, and Definitions												X
49 CFR 172*	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information and Training	X	X										
49 CFR 173*	Subpart I - Class 7 (Radioactive) Materials	X	X										
401 KAR 4*	Water Resources	X	X										
401 KAR 5	Water Quality	X	X										
401 KAR 5:031	Surface Water Standards	X	X										
401 KAR 5:055	KPDES Permit	X	X										
401 KAR 30	General Administrative Procedures												X
401 KAR 31	Identification and Listing of Hazardous Waste Standards Applicable to Generators of Hazardous Waste	X	X										
401 KAR 32	Standards Applicable to Generators of Hazardous Waste												X
401 KAR 33	Standards Applicable to Transporters of Hazardous Waste												X
401 KAR 35	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities												X

*Additions to Table 7 (September 1996)

DWG. NO. K/GA 97-1184-R2(D)

Allocation of Applicable Standards to Requirement Categories

Standards		Define Safety Envelope	Operate Within Safety Envelope	Mitigate Deterioration of Cylinders	Mitigate Damage to Cylinders	Manage Non-Complaint Cylinders	Improve Process Controls	Improve Staffing and Training	Monitor System Performance	Monitor Containment Integrity	Evaluate Containment Integrity	Obtain Resources	Integrate System Operations
401 KAR 36	Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities												X
401 KAR 37	Land Disposal Restrictions	X	X										
401 KAR 38	Hazardous Waste Permitting Process	X	X										
401 KAR 39	Hazardous Waste Fees												X
401 KAR 40	Enforcement and Compliance Monitoring Hazardous Waste		X										
401 KAR 47	Solid Waste Facilities												X
401 KAR 48	Standards for Solid Waste Facilities												X
401 KAR 50	General Administrative Procedures												X
401 KAR 51*	New Source Requirements: Nonattainment Areas	X	X										
401 KAR 53*	Ambient Air Quality		X										
401 KAR 57*	Hazardous Pollutants		X										
401 KAR 59	New Source Standards	X	X										
401 KAR 61*	Existing Source Standards	X	X										
401 KAR 63	General Standards	X	X										
ANS 8.1	Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors	X	X				X	X	X	X			
ANS 8.3	Criticality Accident Alarm System	X	X				X	X	X	X			
ANS 8.7	Guide for Nuclear Criticality Safety in Storage of Fissile Materials	X	X				X	X	X	X			
ANS 8.19	Administrative Practices for Nuclear Criticality Safety	X	X				X	X	X	X			
ANS 8.20	Nuclear Criticality Safety Training						X	X					
ANSI Z117.1	Safety Requirements for Confined Space, 1995							X					
ANSI Z136.1-1993:	Safety Use of Lasers							X					
DOE N441.1	Radiological Protection for DOE Activities		X										
DOE 5400.5*	Radiation Protection of the Public and the Environment (Until superseded by 10 CFR 824)		X										
DOE 5480.21*	Unreviewed Safety Questions	X	X										
DOE 5840.22*	Technical Safety Requirements	X	X										
DOE 5840.23*	Nuclear Safety Analysis Reports	X	X										
DOE 5820.2A*	Radioactive Waste Management	X	X										
NIOSH 1981	Work Practice Guide for Manual Lifting		X										
TDEC 1200-1-7*	Solid Waste Disposal System		X										
TDEC 1200-1-11.01*	Hazardous Waste Management System: General		X										
TDEC 1200-1-11.02*	Identification and Listing of Hazardous Waste		X										
TDEC 1200-1-11.03*	Notification Requirements and Standards Applicable to Generators of Hazardous Wastes		X										
TDEC 1200-1-11.04*	Permit Requirements and Standards Applicable to Transporters of Hazardous Waste		X										
TDEC 1200-1-11.06*	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities		X										

*Additions to Table 7 (September 1996)

DWG. NO. K/GA 97-1164-R2(E)

Allocation of Applicable Standards to Requirement Categories

DWG. NO. K/GA 97-1184-R2(F)

Standards		Define Safety Envelope	Operate Within Safety Envelope	Mitigate Deterioration of Cylinders	Mitigate Damage to Cylinders	Manage Non-Complaint Cylinders	Improve Process Controls	Improve Staffing and Training	Monitor System Performance	Monitor Containment Integrity	Evaluate Containment Integrity	Obtain Resources	Integrate System Operations
TDEC 1200-1-11.10*	Land Disposal Restriction		X										
TDEC 1200-3-1*	General Provisions		X										
TDEC 1200-3-2*	Definitions	X	X										
TDEC 1200-3-3*	Ambient Air Quality Standards	X	X										
TDEC 1200-3-5*	Visible Emissions		X										
TDEC 1200-3-6*	Non-Process Emissions Standards	X	X										
TDEC 1200-3-8*	Fugitive Dust	X	X										
TDEC 1200-3-9*	Construction and Operating Permits		X										
TDEC 1200-3-11*	Hazardous Air Contaminants		X										
TDEC 1200-3-16*	New Source Performance Standards		X										
TDEC 1200-3-18*	Volatile Organic Compounds		X										
TDEC 1200-3-20*	Limits on Emissions Due to Malfunctions, Start-ups and Shutdowns		X										
TDEC 1200-3-22*	Lead Emission Standards		X										
TDEC 1200-3-26*	Administrative Fee Schedule												X
TDEC 1200-4-1*	General Water Quality Provisions		X										
TDEC 1200-4-3*	Tennessee Water Quality Standard	X	X										
TDEC 1200-4-10*	Tennessee NPDES Permit Regulation			X									
49 CFR	Transportation	X	X		X	X							
DOE 4700.1	Project Management System		X										
DOE 5400.1	Environmental Protection	X	X										X
DOE 5480.7A	Fire Protection		X										
DOE 5480.19	Conduct of Operations Requirements for DOE Facilities		X	X	X	X	X	X	X	X	X		X
DOE 5480.24	Criticality Safety	X	X										
DOE 5480.31	Startup and Restart of Nuclear Facilities												X
DOE 5633.3B	Control and Accountability of Nuclear Materials		X		X	X							
DOE 6430.1A	General Design Criteria		X										
USEC-651, Rev. 7	Uranium Hexafluoride: A Manual of Good Handling Practices		X	X	X								
Directors' Findings and Orders (DFO), State of Ohio Environmental Protection Agency			X										
ANSI N14.1	Uranium Hexafluoride - Packaging for Transportation		X	X									
ASME Boiler and Pressure Vessel Code			X	X	X	X							
National Board Inspection Code			X	X	X	X							

*Additions to Table 7 (September 1996)

APPENDIX C

PERSONNEL TRAINING AND QUALIFICATION STANDARDS

This appendix provides the education, experience and training standards for personnel in the system.

1. Type indicates that the position was assessed as the following type position as described in 5480.20A, Chapter I and IV.

MGR	Manager
SUP	Supervisor
O	Operators
T	Technician
MA	Maintenance Personnel
TS	Technical Staff
TQ	Training Organization Personnel

2. Type indicates that the position was assessed as the following type position as described in 5480.20A, Chapter I.

S	Subcontractor

PERSONNEL TRAINING AND QUALIFICATION STANDARDS

Surveillance and Maintenance Function

Type	Function	Education	Experience	Training
MGR	Line Manager	Baccalaureate in engineering or related science	Nuclear 4 yrs	Facility specific qualification based on background
SUP	Supervisor	High school diploma or equivalent	Nuclear 3 yrs	Job specific qualification based on analysis. Certification required if working on fissionable material.
O	Cylinder Inspectors	High school diploma or equivalent	Job Related 1 yr	Job specific qualification based on analysis.
T	Environmental Monitoring Technicians	High school diploma or equivalent	Job Related 1 yr	Job specific qualification based on analysis.
T	HP Technicians	Rad Con Requirements	Job Related 1 yr	Job specific qualification based on analysis that satisfied 10 CFR 835
NA	Security Officers	No requirements in 5480.20A	NA	NA
O	Decontamination Operators	High school diploma or equivalent	Combination of job related experience and education 3 yrs	Job specific qualification based on analysis. Certification required if working on fissionable material.

Type	Function	Education	Experience	Training
TS	Health & Safety Representatives	Baccalaureate in engineering or related science	Job related 2 yrs Nuclear 1 yr	Job specific training and education based on assigned duties.
TS	NMC&A Personnel	Baccalaureate in engineering or related science	Job related 2 yrs Nuclear 1 yr	Job specific training and education based on assigned duties.
T	Qualified NBIC	High school diploma or equivalent	Job related 1 yr	Certified per National Board Inspection Code Owner/User Certification.
O	Chemical Operators	High school diploma or equivalent	Job related 2-3 yrs	Job specific qualification based on analysis. Certification required if working on fissionable material.
O	Material Handlers	High school diploma or equivalent	Job related 1 yr	Job specific qualification based on analysis. Certification required if working on fissionable material.
MA	Maintenance Personnel	High school diploma or equivalent	Maintenance Related: 1 yr	Job specific qualification based on analysis. Certification required if working on fissionable material.
TS	Metallurgists	Baccalaureate in engineering or related science	Job related 2 yrs Nuclear 1 yr	Job specific training and education based on assigned duties.
T	Industrial Hygiene Technicians	High school diploma or equivalent	Job related 2 yrs Nuclear 1 yr	Job specific training and education based on assigned duties.
MA	Painters	High school diploma or equivalent	Maintenance related 1 yr	job specific qualification based on analysis.

Type	Function	Education	Experience	Training
TS	Quality Assurance and evaluation personnel	Baccalaureate in engineering or related science	Job related 2 yrs Nuclear 1 yr	Job specific training and education based on assigned duties.
T	Nondestructive equipment personnel	High school diploma or equivalent	Job related 1 yr	Qualified per American Society of Nondestructive Testing recommended practice SNT-TC-1A (Society of Nondestructive Testing - Technical Council - first document) or American Welding Society Certified Weld Inspector.
TS	System Safety Engineers	Baccalaureate in engineering or related science	Job related 2 yrs Nuclear 1 yr	Job specific training and education based on assigned duties.
O	Emergency Preparedness/ response team	High school diploma or equivalent	Job related 2 yrs	Job specific qualification based on analysis. Certification required if working on fissionable material.
TS	Procedure Writer	Baccalaureate in engineering or related science	Job related 2 yrs Nuclear 1 yr	Job specific training and education based on assigned duties.
TQ	Training Personnel	High school diploma or equivalent	Coordinator: Nuclear 2 yrs Onsite 6 mos Instructors: Consistent with material being presented	Education and/or training at or higher than the level of the normal student population in the subject area being taught.

Type	Function	Education	Experience	Training
T	Lab Technicians	High school diploma or equivalent	Job related 1 yr	Job specific qualification based on analysis.
S	Construction Contractors	NA	NA	"Meet the qualification requirements for the job to be performed."
TS	Engineering Support Personnel	Baccalaureate in engineering or related science	Job related 2 yrs Nuclear 1 yr	Job specific training and education based on assigned duties.
T	Equipment Testing/ Inspection Personnel	High school diploma or equivalent	Job related 1 yr	Job specific qualification based on analysis.
NA	Records Management Personnel	No requirements in 5480.20A	NA	NA

Handling and Stacking Function

Type	Function	Education	Experience	Training
O	Spotter	High school diploma or equivalent	Job related 1 yr	Job specific qualification based on analysis. Certification required if working on fissionable material.
T	Cylinder Inspector	High School diploma or equivalent	Job related 1 yr	Job specific qualification based on analysis.

Type	Function	Education	Experience	Training
TS	Hoisting & Rigging Representative	Baccalaureate in engineering or related science	Job related 2 yrs Nuclear 1 yr	Job specific training and education based on assigned duties.
O	Equipment Operator	High School Diploma or equivalent	Job related 1 yr	Job specific qualification based on analysis. Certification required if working on fissionable material.
O	Operator to Set Saddles	High School Diploma or equivalent	Job related 1 yr	Job specific qualification based on analysis. Certification required if working on fissionable material.
MA	Maintenance Personnel	No requirements in 5480.20A	Maintenance related: 1 yr	Job specific qualification based on analysis. Certification required if working on fissionable material.
O	Hoisting & Rigging Crew	High School Diploma or equivalent	Job related 1 yr	Job specific qualification based on analysis. Certification required if working on fissionable material.

Contents Transfer Function

Type	Function	Education	Experience	Training
O	Operator	High school diploma or equivalent	Job related 1 yr	Job specific qualification based on analysis. Certification required if working on fissionable material.

Type	Function	Education	Experience	Training
MA	Maintenance Personnel	High school diploma or equivalent	Job related 1 yr	Job specific qualification based on analysis. Certification required if working on fissionable material.
T	Equipment Testing/ Inspection Personnel	High school diploma or equivalent	Job related 1 yr	Job specific qualification based on analysis. Certification required if working on fissionable material.

Off-Site Transport Function

Type	Function	Education	Experience	Training
O	Hoisting & Rigging Crew	High school diploma or equivalent	Job related 1 yr	Job specific qualification based on analysis. Certification required if working on fissionable material.
T	Qualified Inspector	High school diploma or equivalent	Job related 1 yr	Job specific qualification based on analysis. Certification required if working on fissionable material.
T	Health Physics Technician	High school diploma or equivalent	Job related 1 yr	Job specific qualification based on analysis that satisfies 10 CFR 835
O	Transport Driver	Not addressed in 5480.20A Licensed per DOT regulations	NA	NA
TS	Transportation Safety Representative	Baccalaureate in engineering or related science	Job related 2 yrs Nuclear 1 yr	Job specific training and education based on assigned duties.

Type	Function	Education	Experience	Training
TS	DOT certified Transportation "Officer"	Baccalaureate in engineering or related science	Job related 2 yrs Nuclear 1 yr	Job specific training and education based on assigned duties.